AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

JUNE, 1959

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Precision Metal Molding

PMM

INCLUDING DIE CASTINGS' MAGAZINE

DIE CASTINGS

EXTRUSIONS

INVESTMENT CASTINGS

PERMANENT MOLD CASTINGS

PLASTER MOLD CASTINGS

SINTERINGS

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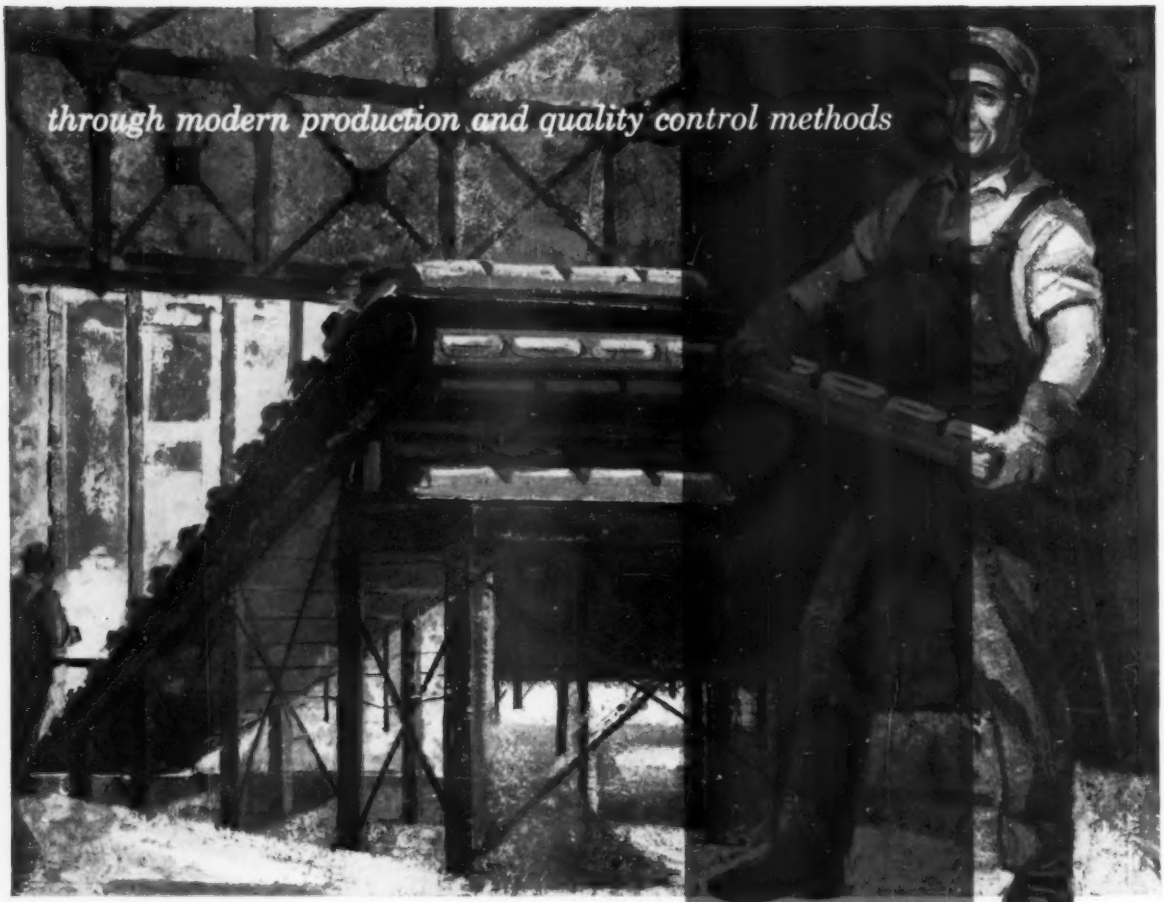
WHERE TO BUY YOUR INVESTMENT CASTINGS

4th Annual

Investment Castings DIRECTORY



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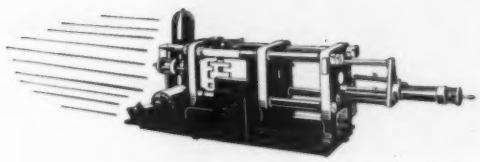
announcement



CAST-MASTER

H-P-M Division — Koehring Company

We are very happy to announce that Cast-Master, nationally known manufacturer of die casting machines and allied equipment, is now a part of Koehring Company and will operate as a division of the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. Designers and builders of precision die casting machinery since 1939, Cast-Master is one of the oldest exclusive manufacturers of this type of machinery in the country. The increased use of die cast parts in the automotive, appliance, electronic and many other industries forecasts a growth potential that will be strengthened by this union with the Koehring Organization.

The complete line of Cast-Master die casting machines will continue to be manufactured at the Bedford, Ohio plant. Operating Management at Cast-Master remains unchanged.

HPM

H939

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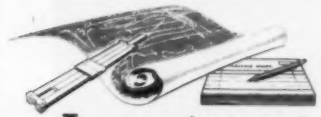
PMM **IN THIS ISSUE** June, 1959: Volume 17 Number 6

COVER



4th Annual

Investment Castings DIRECTORY

THE FOURTH ANNUAL directory of the investment casting industry is presented with this issue. As in previous directories, this one lists all of the custom fabricators of investment castings, suppliers to the industry, and the equipment builders. Every effort has been made to make this directory as complete and as useful as possible; it starts on page 55.

FEATURE ARTICLES

25 MECHANICAL PROPERTIES OF 17-4PH
F. Kenneth Iverson of Cannon-Muskegon Corp. discusses the effect that aging time and temperature has on this alloy.

27 AN IMPROVED ENGINEERING MATERIAL
How vacuum casting in a consumable arc melting furnace improves the mechanical properties of high alloy tool steels.

28 ONE CASTING MACHINE FOR ALUMINUM OR ZINC
With vacuum die casting, you can make one machine capable of casting either aluminum or zinc by changing the melting pot.

30 BIG ALUMINUM EXTRUSIONS
Design advantages of aluminum extrusions have been expanded by giant extrusion presses making larger shapes, longer lengths.

32 DIE CAST PARTS AT 1/5 THE COST
When one firm realized it was machining away its profits on a part, it switched to die casting for 80% savings.

34 INVESTMENT CAST CAMERA BODY
How investment casting provided complexity, thin wall sections, and surface finish specifications at 25% less cost.

36 POWDER METALLURGY OF BERYLLIUM
Beryllium has gained prominence with the coming of the space age; here are the vital statistics on this metal.

38 D-C CASTING OF COPPER AND COPPER ALLOYS
You might be surprised at the many economies possible through the direct chill, continuous casting of copper and copper alloys.

40 INVESTMENT CASTING INSTITUTE STANDARDS
This is the first installment of a three-part article, and it covers purpose, surface quality, and X-ray standards.

43 PROPERTIES OF EXTRUDED ALLOYS
No. X in a series on the properties of extruded metals. This month, some of the commonly extruded magnesium alloys are covered.

45 DESIGN TIPS
Standard notes, section drawings, and dimensions of extruded aluminum dovetails.

91 PRESSURE TIGHT SINTERINGS
Sinterings can be made pressure tight and can be successfully electroplated by properly applying the right polyester plastic.

FINISHING SECTION

49 FAST, ECONOMICAL MACHINING OF SINTERINGS
A small, versatile milling machine saves a lot of time by milling a slot and drilling a hole in a sintering in one pass.

50 CONTINUOUS CLEANING AND PAINTING
A new approach to finishing metal combines cleaning with application of a coating of paint in a single conveyorized unit.

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TARGET the MOON!

When the first space craft reaches the moon, it will owe part of its success to the high purity of the various alloys used to cast many of its parts . . . metal that was melted in **CRUCIBLES.**

Whether you're making valves or Vanguards, gear-cases or guided missiles, CRUCIBLE MELTING is the most flexible, reliable and economical means of obtaining high purity metal — in any quantity — quickly and economically!

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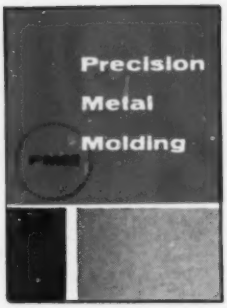

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BPA

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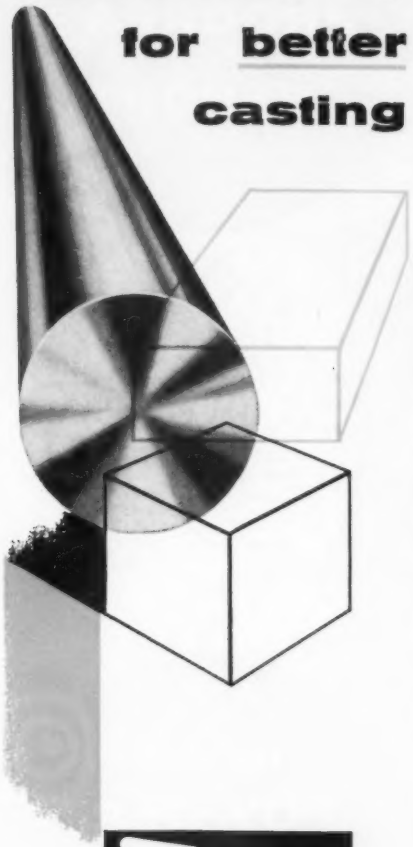
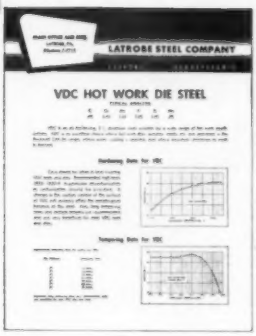
Produced by LATROBE Metalmasters for better die casting dies...



VDC

HOT WORK STEEL

Air hardening, high vanadium, Type H-13



Regardless of how intricate your zinc, aluminum or magnesium die casting job may be, Latrobe's VDC can fill your need for faster die production, longer runs and more economical parts production.

Easy to machine, VDC has a sound internal structure and freedom from porosity. It responds uniformly to heat treatment, can be water-cooled in service and possesses excellent resistance to impact, wash and heat checking.

For your next die casting die, use the die steel made by Metalmasters who *know* your requirements . . . VDC! A wide range of stocks is available from district warehouses located near you.

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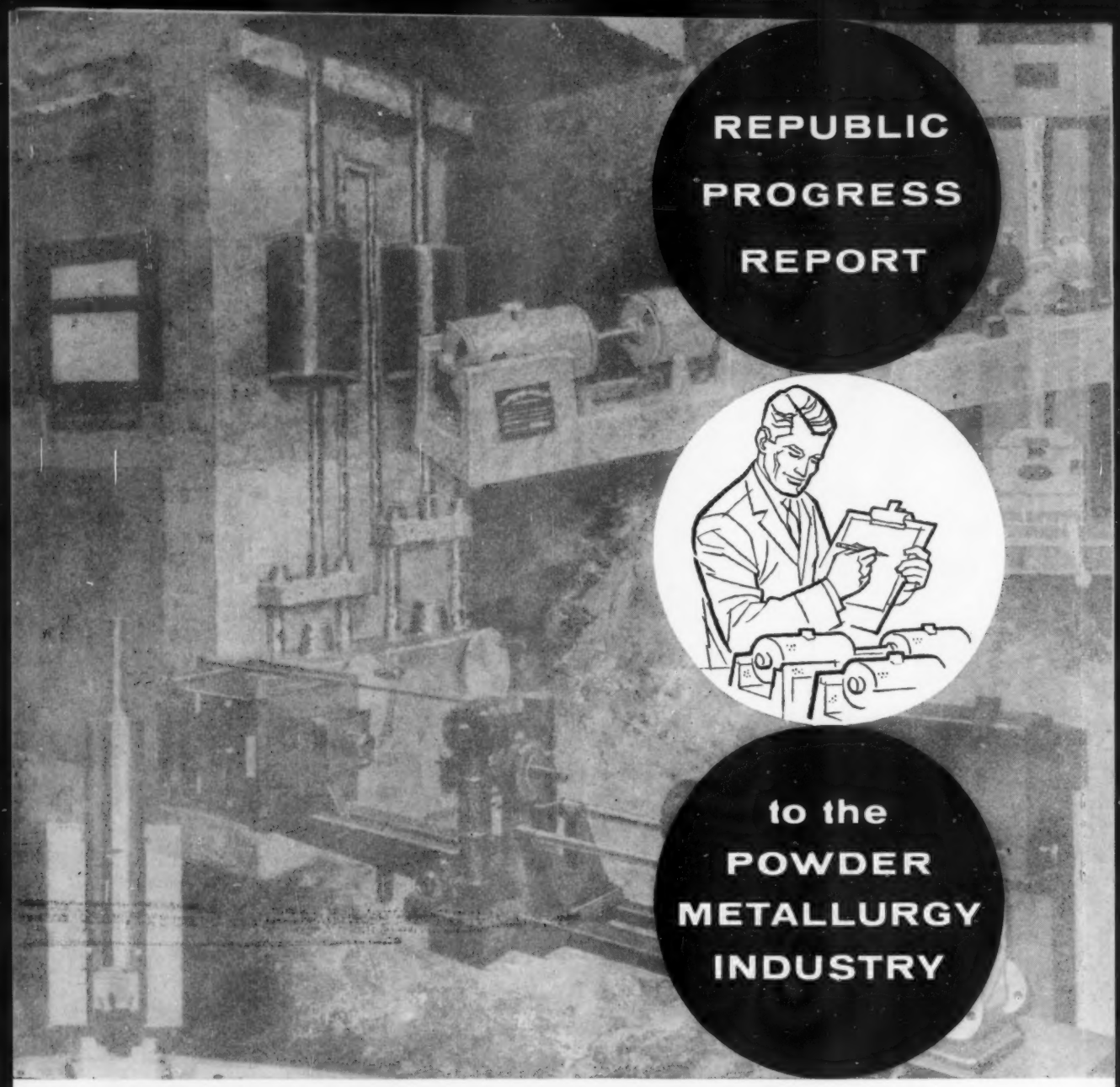

ON ADDITIONAL FATIGUE TESTING DATA...

Additional Fatigue Test Data on Type HS6460 High Strength Powder

SET 3—COMBINED CARBON 0.20% (Initial Tensile—38,000 psi)

CYCLES	STRESS (psi)
100,000	21,200
1,000,000	18,500
10,000,000	17,000

SET 4—COMBINED CARBON 0.20% (Initial Tensile—57,000 psi)

100,000	25,500
1,000,000	21,000
10,000,000	19,000

Procedure Used to Obtain Test Results

Material—Type HS6460 with 1% zinc stearate. Single press and sintered standard A.S.T.M. Fatigue Bar—.300" dia. Testing machine—R. R. Moore Rotating Beam.

Sintering conditions for Set 3—Endothermic atmosphere, dew point +30° F, 2050° F, 45 minutes at heat (extended time because of size). Briquetting pressure—60,000 psi. Density—6.36.

Sintering conditions for Set 4—Endothermic atmosphere, dew point +30° F, 2050° F, 45 minutes at heat (extended time because of size). Briquetting pressure—80,000 psi. Density—6.67.

For more information, write Republic Steel, Dept. PM-7926, 1441 Republic Building, Cleveland 1, Ohio.

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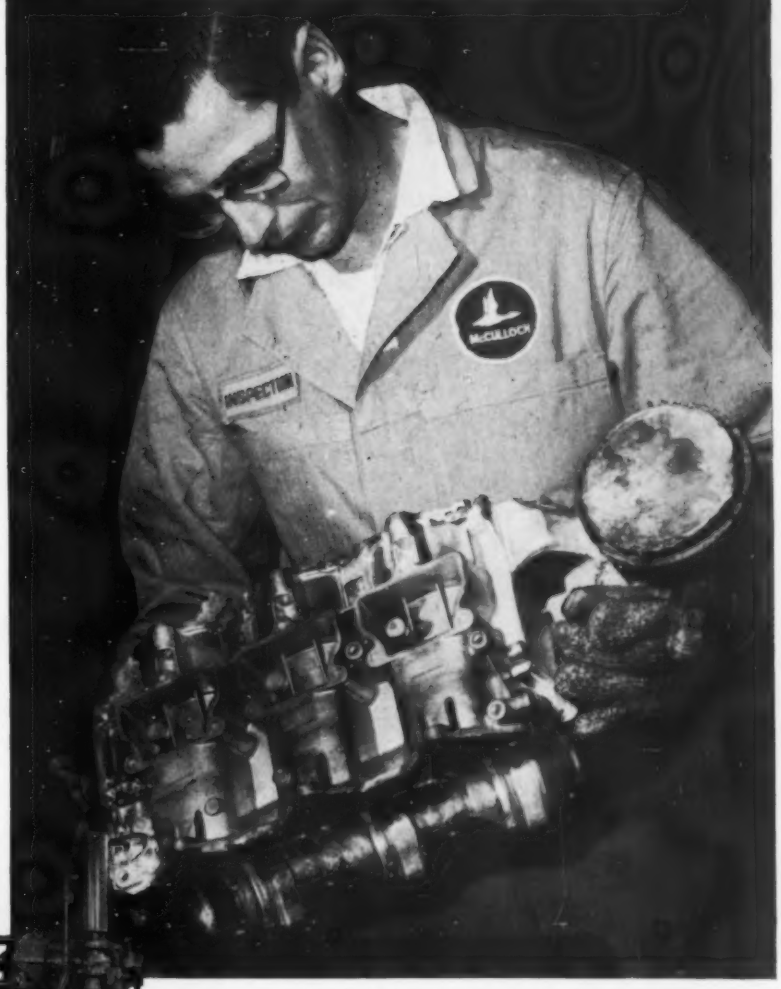
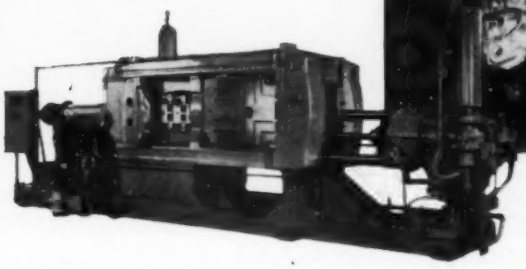
OUR DIES WOULDN'T RUN ON ANYTHING BUT LESTERS...

WE TRIED... AND FOUND OUT!

says: MILTON R. HOEPPNER
Administrative Assistant
McCulloch Corporation
Los Angeles, California





"Orders were building up for our largest outboard motor die castings, so we decided to step up production by farming out the dies for the aluminum castings. It was a good idea except for one thing—no one else in this area owned an 800 Ton Lester—the kind we were using to cast the 30 lb. block for the motor.

"Without the Lester, they just couldn't give us comparable quality—the kind we demand for our products. As a direct result, *we* ordered more Lesters. In fact, two of them are 1000 Ton machines, with bigger platens and more speed and pressure, so we'll be able to make even better parts ourselves. By July, 1959, we'll have nine Lesters, ranging from 600 to 1000 ton clamp, running at McCulloch Motors."

The seeming limits of fine die casting are being pushed back every day by Lesters. If you are planning demanding die casting, TEST A LESTER! You'll be pleased and profited by the results.

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How **DENISON MULTIPRESS** cuts costs of **COMPACTING**

Production tripled with **DENISON** Multipress in compacting shaped charges at **JET RESEARCH**

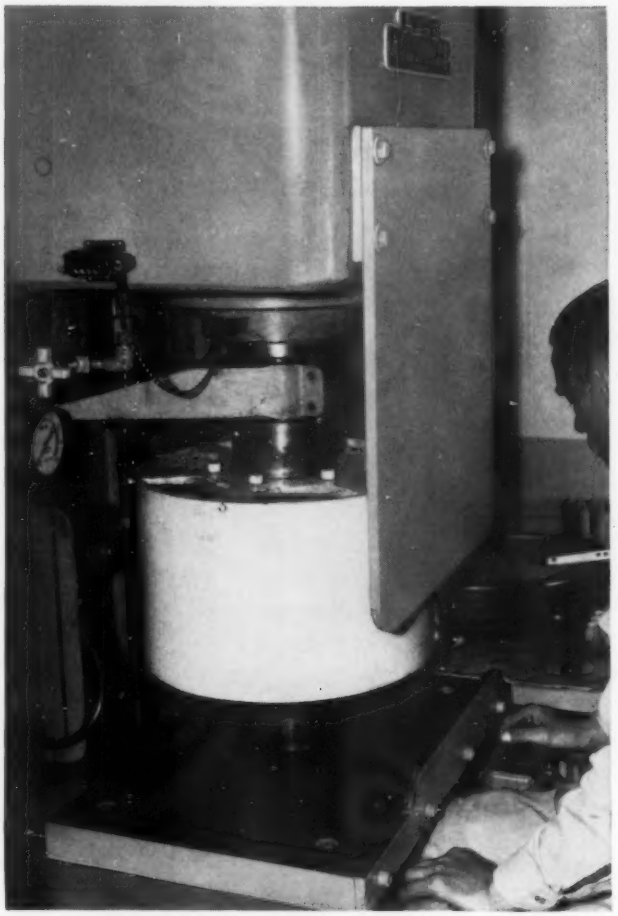
...scrap virtually eliminated by precise control of density obtained hydraulically

Density in compacting explosives is being duplicated exactly at Jet Research Center, Inc. with Denison hydraulic Multipresses. Formerly done on mechanical presses, production has now been tripled to cut manufacturing costs substantially.

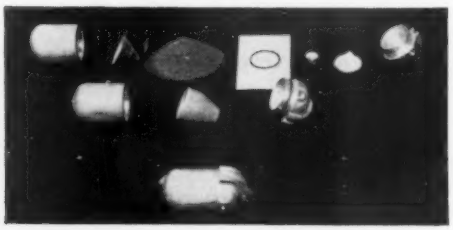
In the production of the shaped charge assembly, a precise amount of explosive is automatically weighed out, placed in a container and loaded in a die. With one, smooth stroke of the hydraulic ram, the charge is compacted to exact density. This density is duplicated from charge-to-charge because the ram will not reverse until its preset pressure is reached.

Production runs in excess of 2,000 assemblies-per-day for Multipress with a minimum of operator training.

Whatever your compacting job or assembly operation may be, savings like these could be duplicated in your plant. Ask the Denison Specialist to show you how. And write today for a descriptive catalog on the complete Multipress line.



300% increase *in production of compacted powders is attained with Denison hydraulic Multipress at Jet Research Center, Inc., Arlington, Texas.*



Components for assembly *of shaped charges used in perforating oil and gas wells.*

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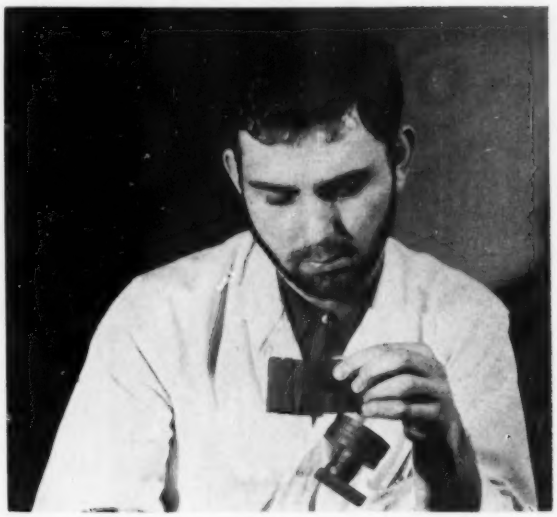
CASTING ABOUT

technical news of applications & processes involving precision metal moldings

CERAMIC MAGNETS are part of the answer which engineers are seeking for high speed aircraft and missiles. On an equal weight basis these magnets have from two to three times the magnetic strength of iron. On a volume basis, they weigh about half as much as iron.

They're made by mixing two or more carefully measured amounts of powered metallic oxides, such as iron oxide and barium oxide. The mixture is then pressed to shape and heat-treated to form a relatively strong ceramic material capable of retaining an induced magnetic field.

Some recent work by engineers in Boeing Airplane Co.'s pilotless aircraft division has shown that these ferrites can be magnetized while the ceramic is being formed under heat and pressure. Magnets made in this manner have longer life and develop stronger magnetic fields. The good magnetic properties of ferrites are retained even at elevated temperatures, another big advantage over metallic magnets.



ELECTRON BEAM MELTING may become a useful industrial tool if some of the work reported at a symposium on electron beam melting is realized. The symposium, sponsored by Alloyd Research Corp., included reports of the latest work at General Electric, Westinghouse, Sylvania, Bell Telephone, National Aeronautics and Space Administration, Massachusetts Institute of Technology, Alloyd Research, American Vacuum Society, National Research Corp., Mallory-Sharon, Airco and High Vacuum Equipment Corp. Zone refining, welding, drip-melting, thin-film evaporation and related subjects were covered.

Some of the promising applications of electron beam techniques reported were zone refining of refractory materials such as tungsten, molybdenum and silicon carbide, welding tungsten wire to molybdenum, welding titanium-bearing stainless steels, welding Inconel-X and salvaging scrap titanium, beryllium, and other materials by drip-melting.

By zone refining, bars of pure silicon 28 isotope have been made. Such unusual operations as seals between molybdenum and alumina appear possible as well as the welding of very thin to thick aluminum. At present Alloyd Research is building an electron beam zone refining unit to produce ultra high purity beryllium.

The electron beam process operates at pressures of about 10^{-6} mm of mercury, this insures thorough degassing of molten metal and welds. A major advantage of the process is the nearly 100% conversion of electric energy to heat. Only minor losses are involved in the filament supply.

PURE COLUMBIUM mill products can now be produced. Experience has been gained by Universal-Cyclops Steel Corp. in rolling columbium sheet and in casting large ingots of columbium and columbium-zirconium alloy. So far the largest sheet of pure columbium produced is 36" x 96" x 0.028" thick. This sheet was rolled from a 9", 325 pound ingot; at the time the largest columbium ingot ever cast.

A columbium, 1% zirconium ingot which weighs 470 lbs. has been cast and will be remelted for further purification. The final billet will be 12" in diameter, the largest section ever cast in columbium.

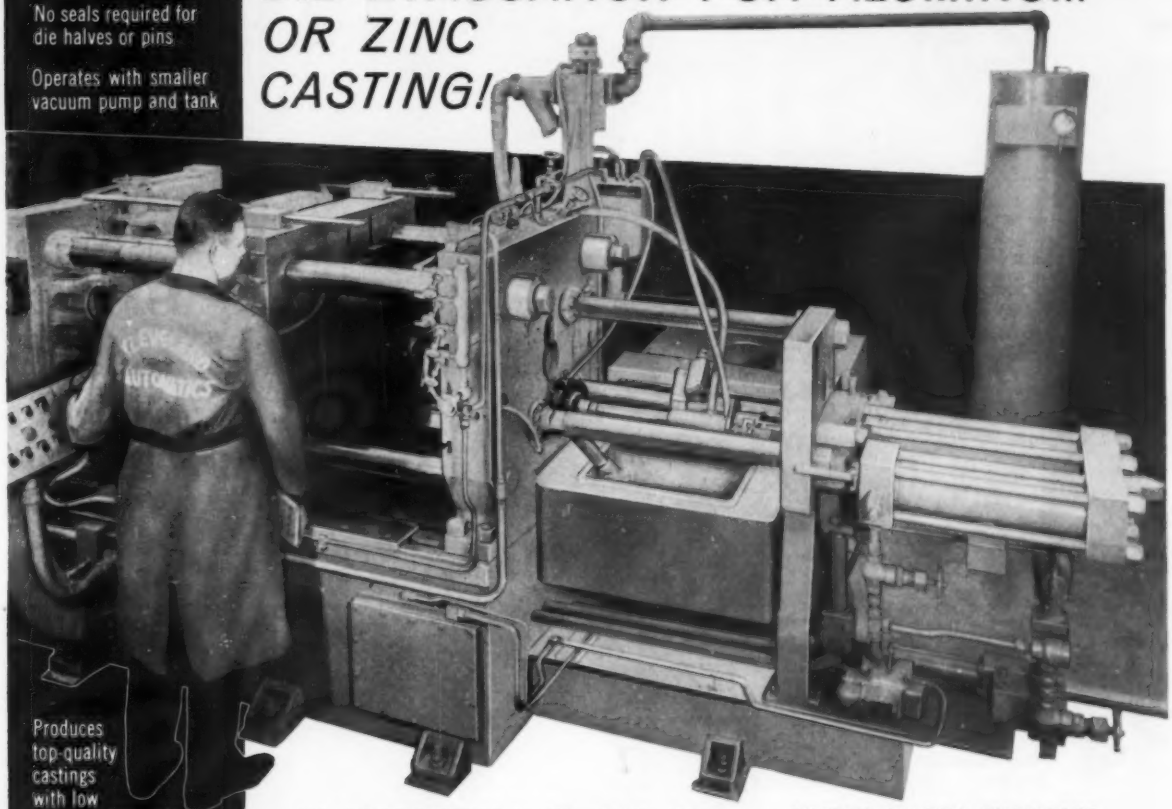
At present, the major use for columbium is in nuclear work where its corrosion resistance and low neutron cross section make it valuable. Both the aircraft and missile industries are considering the metal for supersonic vehicles. Some of the columbium alloys have promising properties for very high temperature-high strength applications.

THE RECOVERY back to an upward trend is consumption of die castings that set in last September is continuing through the first quarter of 1959. Declines in sales of automobiles and appliances were largely responsible for the relatively poor three-quarters of last year. Starting with the introduction of new models in the automobile industry in September, the job shop die casting industry turned up and the improvement has continued through the first quarter of this year. All presently available reports indicate that business will continue good through the remainder of 1959 according to the American Die Casting Institute.

WITH THE MORTON SYSTEM...

CLEVELAND TAKES THE LEAD IN VACUUM LADLING AND DIE EVACUATION FOR ALUMINUM OR ZINC CASTING!

- Lowest cost of any vacuum system
- Proven in production
- No shrouds or hoods to confine die area
- No seals required for die halves or pins
- Operates with smaller vacuum pump and tank



- Produces top-quality castings with low injection pressures
- Provides fast operation with less operator attention
- Machine maintenance reduced to minimum
- Less flash—cleaner dies—fewer rejects
- Automatic die and machine lubrication including plunger tip
- Template programmed operation sequences
- The ultimate in machine operation flexibility

IN OPERATION in Cleveland's Die Casting Development Center is the 400-ton Cleveland 400-N Machine shown above. This Cleveland incorporates the lowest cost, most efficient vacuum ladling and die evacuation system in existence today!

For months, this machine has been producing an extremely thin-walled aluminum casting, having near-zero porosity and superb surface finish, at rates exceeding 300 shots per hour.

The casting is produced with a 4" dia. shot cylinder from a 1000 lb. charge in the accumulator, and by automatically ladling the aluminum and evacuating the die and shot cylinder from the vacuum system, which operates under a vacuum of 29.6 inches of mercury. No shrouds or die seals, etc., are used. (If desired, a 2000 lb. shot pressure, or an intensifier to provide 5000 lbs., can be supplied.)

SIMPLY SWITCH FURNACES TO CHANGE FROM ALUMINUM TO ZINC PRODUCTION

Note the unique furnace arrangement shown. This is a 30KW induction melting furnace on wheels, riding on rails. The entire furnace can be rolled out from under the shot end. By mounting another die, rolling in a second furnace charged with a different alloy or metal, and re-programming the machine controls, this Cleveland is quickly back into production!

A few of the many advantages of Cleveland Vacuum Die Casting Machines are itemized at the left. To convince yourself of Cleveland's superiority in vacuum die casting, schedule your visit to see this machine in operation, or call in a Cleveland field engineer.

THE CLEVELAND AUTOMATIC MACHINE COMPANY

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Cincinnati 12, Ohio

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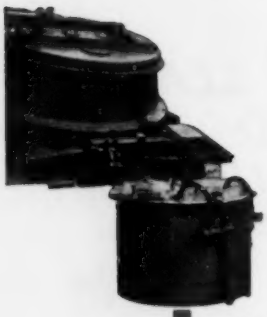
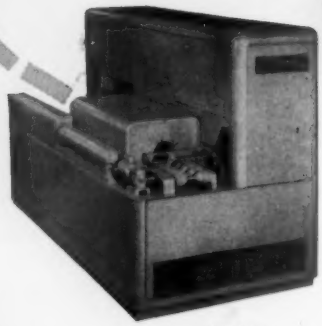


60 Cycle
Non-Ferrous Melting



60 Cycle
Billet Heating

High Frequency
Melting

High Frequency
Heat Treating

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OUR PRODUCTS

- 60 CYCLE CORE-TYPE MELTING FURNACES
- 60 CYCLE CORELESS FURNACES
- 60 CYCLE BILLET HEATERS
- DUAL AND HIGH FREQUENCY FORGE HEATERS
- HEAT TREAT AND BRAZING EQUIPMENT, 60 CYCLES TO 450 KC
- HIGH FREQUENCY MELTING FURNACES
- SPARK GAP CONVERTERS

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specializing in high frequency melting equipment and spark gap converters.

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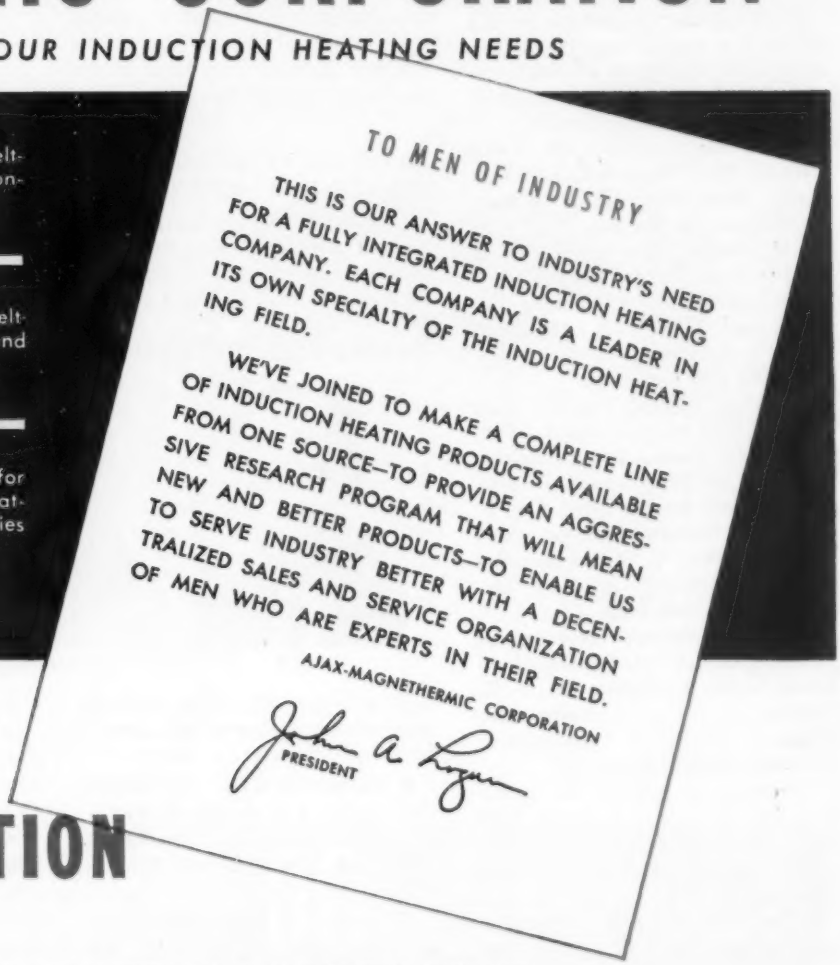
specializing in billet heating for extrusion and forging, heat treating and annealing in frequencies from 60 cycle to 450 KC.



TO MEN OF INDUSTRY

THIS IS OUR ANSWER TO INDUSTRY'S NEED FOR A FULLY INTEGRATED INDUCTION HEATING COMPANY. EACH COMPANY IS A LEADER IN ITS OWN SPECIALTY OF THE INDUCTION HEATING FIELD.

WE'VE JOINED TO MAKE A COMPLETE LINE OF INDUCTION HEATING PRODUCTS AVAILABLE FROM ONE SOURCE—TO PROVIDE AN AGGRESSIVE RESEARCH PROGRAM THAT WILL MEAN NEW AND BETTER PRODUCTS—TO ENABLE US TO SERVE INDUSTRY BETTER WITH A DECENTRALIZED SALES AND SERVICE ORGANIZATION OF MEN WHO ARE EXPERTS IN THEIR FIELD.

AJAX-MAGNETHERMIC CORPORATION

John A. Lyon
PRESIDENT

OUR ~~ONLY~~ BUSINESS

CORPORATION

TRENTON 7, N. J.
TRENTON 5, N. J.
YOUNGSTOWN 7, OHIO

For more information circle No. 52 on the Reader Service Card

NEWS OF INDUSTRY & ASSOCIATIONS

activities of people, companies & groups in the precision metal molding industries

AZI ELECTS OFFICERS; SEES ZINC USAGE RISE

KENLY

SNYDER

CARUS

CAMPBELL

At the AMERICAN ZINC INSTITUTE'S recent 41st annual meeting in Chicago, R. G. Kenly was elected president. Kenly is a vice president of The New Jersey Zinc Co.

These vice presidents were elected: T. A. Campbell, The Anaconda Sales Co.; H. D. Carus, Matthiessen & Hegeler Zinc Co.; E. H. Snyder, Combined Metals Reduction Co. Re-elected were G. H. LeFevre, U. S. Smelting Refining and Mining Co., treasurer, and J. L. Kimberley, executive vice president and secretary.

Directors elected for the term expiring 1962 were: Victor A. Allen, Tri-State Zinc, Inc.; Andrew Fletcher, St. Joseph Lead Co.; C. R. Ince, St. Joseph Lead Co.; F. R. Jeffrey, National Zinc Co., Inc.; G. H. LeFevre, U. S. Smelting Refining and Mining Co.; E. S. McGlone, The Anaconda Co.; J. S. Smart, Jr., American Smelting and Refining Co.; E. H. Snyder, Combined Metals Reduction Co.; S. D. Strauss, American Smelting and Refining Co.; Jean Vuillequez, American Metal Climax, Inc.

Directors elected to fill vacancies for the term expiring 1960 were T. A. Campbell, The Anaconda Sales Co., and W. G. Woolf, The Bunker Hill Co.

In a discussion on production and consumption of zinc in the U. S., C. R. Ince, St. Joseph Lead Co. vice president, forecast that consumption of slab zinc would rise to 960,000 tons for an increase of 17% over 1958. He based his prediction on correlation between present levels of zinc consumption and the Federal Reserve Board Index of Durable Manufactures, supported by reports of reliable economic surveys that the Index would increase some 10% to 159 this year.

BELDEN HEADS PMEA

Byron B. Belden, Baldwin-Lima-Hamilton Corp., has been re-elected president of the POWDER METALLURGY EQUIPMENT ASSOCIATION for 1959-60. Elected directors were Edward J. Hoch, Jr., Drever Co.; Norbert K. Koebel, Lindberg Engineering Co.; Clemens C. Sutinen, Mannesmann-Meer Engineering & Construction Co.

NATIONAL LEAD NAMED BUNKER HILL AGENT

NATIONAL LEAD CO. has been appointed sales agent for the distribution of BUNKER HILL zinc-base alloys in the United States, excluding the West Coast. National Lead will also warehouse the alloys.

FORMS CONSULTING FIRM

Melvin W. Isaacson, former general sales manager of the Metals Processing Div., Curtis-Wright Corp., has established a management consulting firm, the M. W. ISAACSON CO. Located at 95 Ruskin Rd., Eggertsville, N. Y., and 420 Lexington Ave., New York, the firm

ISAACSON

specializes in marketing and new product development in the metalworking industry. Before joining Curtis-Wright, Isaacson was general sales manager of the Powdered Metal Products Div., Yale & Towne.

HARPER ELECTRIC PROMOTES EXECUTIVES

ROTH

EBERHARDT

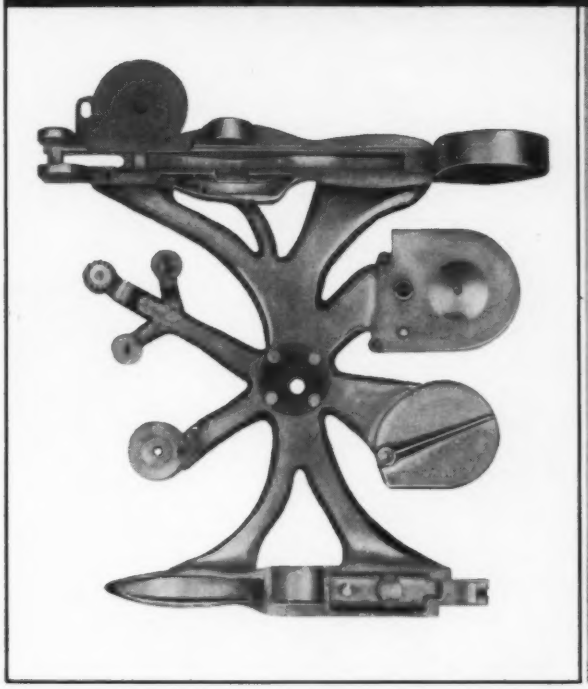
CHUTTER

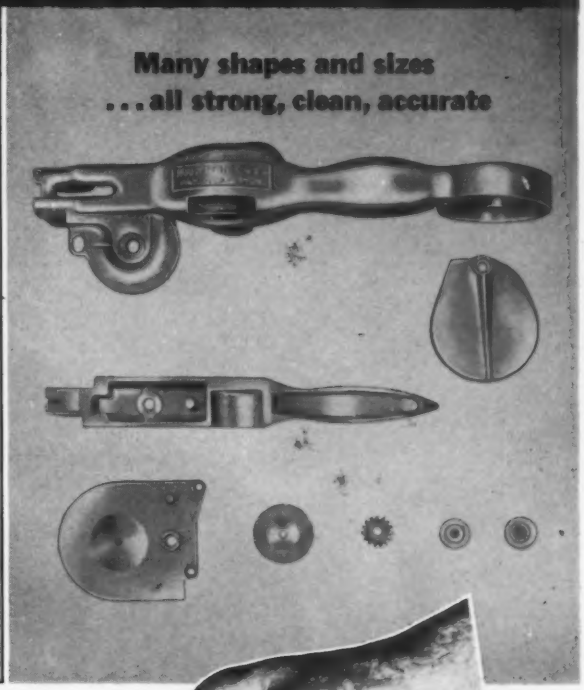
At a recent election held by HARPER ELECTRIC FURNACE CORP.'S board of directors:

- Harper D. Roth was elected vice president in charge of marketing. Roth, who joined the firm in 1950, had been treasurer since 1954.
- Warren J. Eberhardt, assistant treasurer since 1956, was elected treasurer.
- George A. Chutter, a representative in New England and eastern New York since 1946, was elected a director.
- Re-elected were Roderick L. Harper, executive vice president; and John Loudon and Ben A. Bovee, vice presidents.

more industry news on page 86

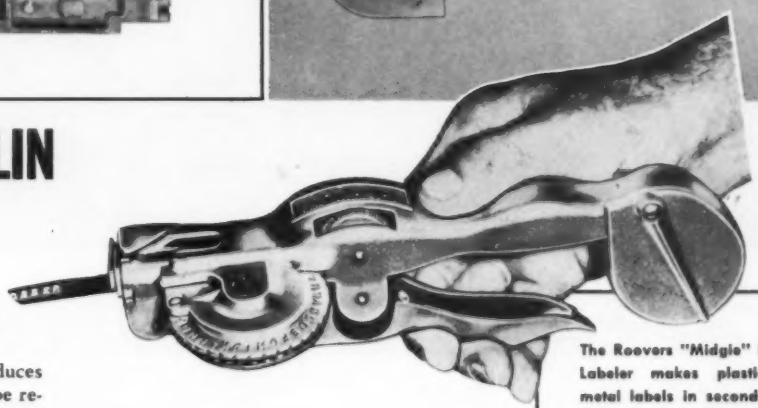
One Die—One Shot . . . 8 PARTS!





Die-Cast by DOLLIN for Roovers "Midgie" Labelers

Each high-speed casting shot produces a gate containing body, handle, tape reset wheel, tape magazine cover, embossing wheel bottom plate and ratchet wheels. Subsequent trimming by Dollin delivers these zinc die-cast parts with close accuracies and a smooth hardware finish, ready for finishing and assembly . . . at low piece cost. The original combination die, with occasional design changes, is still in first class condition, after 19 years and 150,000 shots.



The Roovers "Midgie" Hand Labeler makes plastic or metal labels in seconds, by embossing permanently raised characters on strips of Monel, stainless steel, aluminum, copper, lead or vinyl plastic. Simply dial the letter or numeral and squeeze the handle. Manufactured by Roovers-Letsch Corporation.

Is there an idea here for you? Dollin welcomes the opportunity to study your requirements and apply similar ingenuity and savings in die-casting your parts. Long experience — skilled die-makers — extensive equipment enable Dollin to produce your zinc and aluminum die-castings from large size down to fractions of an ounce, at lowest cost.

DOLLIN CORPORATION 25th ANNIVERSARY 1934-1959 Die-Castings

Submit prints or samples of parts for engineering advice and quotation, without obligation. Write for 16-page brochure showing Dollin's facilities and services.

Dollin Corporation, 614 So. 21st St., Irvington 11, N. J.

Sales Offices: Boston • Buffalo • Canton • Chicago • Detroit
Greensboro • Louisville • Memphis • Philadelphia • St. Paul

See "Yellow Pages" for nearest office.

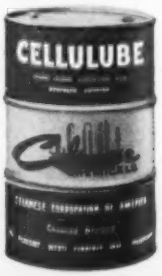
DOLLIN Zinc & Aluminum DIE-CASTINGS

For more information circle No. 25 on the Reader Service Card

Cellulubes by Celanese shoulder the big jobs . . .

In standard tests, Cellulubes were dripped and flooded onto molten metal at 1500° F without igniting! In a standard flammability test, Cellulubes were sprayed under pressure onto burning oil-soaked cotton waste; they actually extinguished the fire on a portion of the flaming material!

No wonder Cellulubes made by the Celanese Corporation of America are specified for big jobs in hydraulics which present potential fire hazards.



FM

Factory Mutual-Approved
(Cellulubes 150 and 220)

CELANESE CORPORATION OF AMERICA, CHEMICAL DIVISION
DEPT. 589-F, 180 MADISON AVENUE, NEW YORK 16, N. Y.

Please send me:

☐ Technical bulletin ☐ Sample of _____ viscosity.

Name _____ Title _____

Company _____

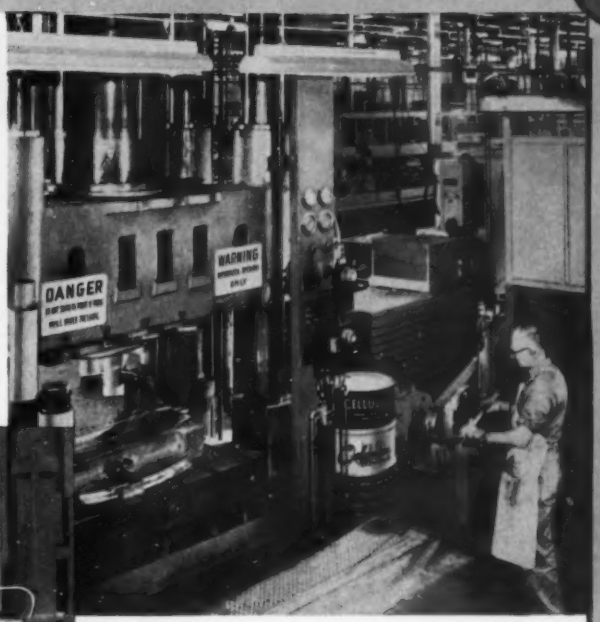
Address _____

City _____ Zone _____ State _____

Application I have in mind _____

U.S.S. INDEPENDENCE, the Navy's newest 60,000-ton supercarrier, takes on 55-gallon drums of Cellulube, part of a six-car trainload. Used to operate giant aircraft elevators, Cellulubes overcome the hazard of fire and explosion. Cellulubes are used in the combat fleet for fire-safe hydraulic duty.

TITANIUM PARTS expanded by heating to 1000°F are transferred from an electric furnace to a powerful hydraulic press. North American Aviation uses fire-resistant Cellulube 220 to protect against the dangers of line fracture or leakage during this form-die quenching operation for making high-strength aircraft parts.



DIE-CASTING MACHINES at Alcoa's Garwood plant are hydraulically actuated. Furnace in foreground shows the proximity of the lines to the molten metal. Lines operate at pressures up to 3500 psi. Cellulube hydraulic fluids minimize the danger of fire.

reduce fire hazards near hydraulic machines

Wherever hydraulic lines pass near a source of ignition, fire-resistant Cellulubes are a must.

The fluids are available in six ranges of viscosity, and they maintain these viscosities under the severest conditions of mechanical shear. Cellulubes display excellent physical and chemical stability. They do not foam, cannot drop additives into the system. In fact, they actually have a cleansing action in machinery. Low compressibility insures efficient power transfer. The good lubricant properties of Cellulubes safeguard equipment life and decrease maintenance.

Let us help you with your hydraulic problems wherever a hazard might exist. Celanese, pioneer in fire-resistant functional fluids, can draw on long field experience and research background in solving your problem. For full technical specifications, send for the "Cellulube Safety Series" manual. If you'd like a sample of Cellulube, please let us know what application you have in mind.

Celanese Corporation of America, Chemical Division, 180 Madison Ave., New York 16, N. Y.

Celanese® Cellulube®

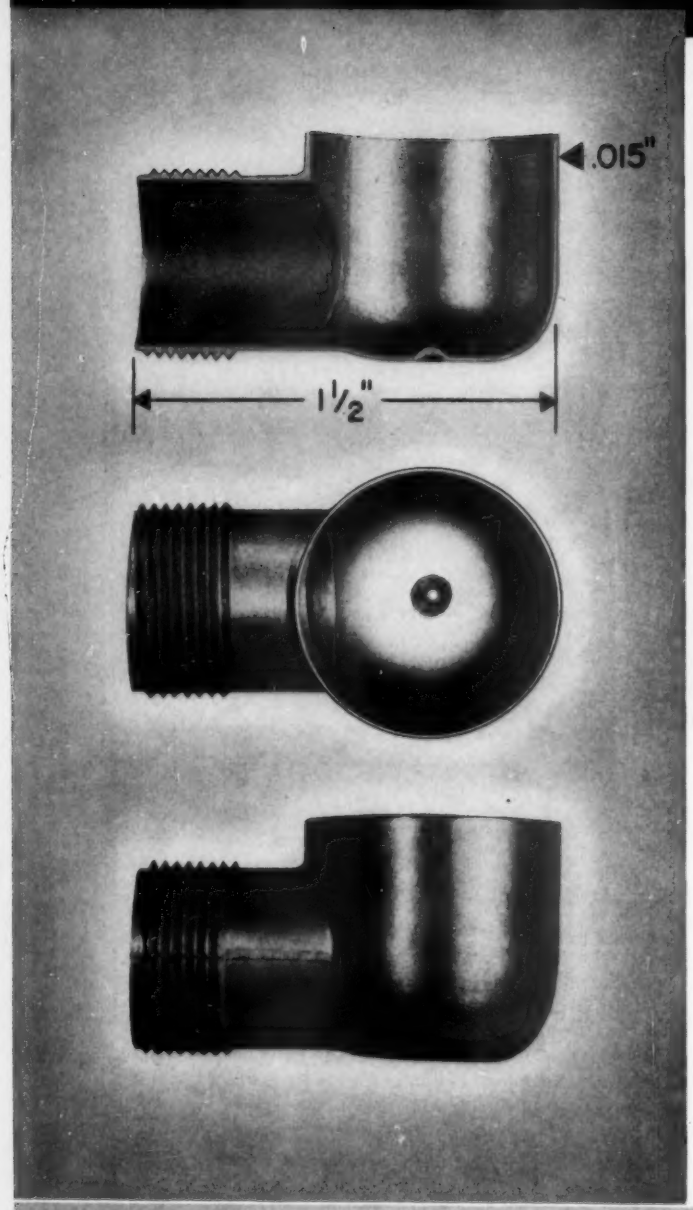
Cellulubes... Celanese CHEMICALS fire-resistant functional fluids

In Canada: Canadian Chemical Company Limited, 2135 Guy St., Montreal, Toronto, Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co. Inc., 180 Madison Ave., New York 16

For more information circle No. 19 on the Reader Service Card

CELANESE CELLULUBES

IT'S LIGHTER THAN YOU THINK!



AND STRONGER, TOO, WHEN DIE CAST with ZAMAK

This thin-wall spark plug shield is a zinc die casting with minimum wall thickness of only .015".

Many zinc die castings are as thin as stampings, yet can be produced in shapes that cannot be duplicated as one-piece stampings.

More and more, engineers are learning that they can design parts for ZAMAK alloy die casting that will compete with either steel stampings or castings of the lightweight metals—and at lower cost.

THE NEW EDITION OF "END USES OF ZINC DIE CASTINGS"

SEND FOR YOUR COPY TODAY

HORSE HEAD® SPECIAL ZINC AND HORSE HEAD ZAMAK ARE PRODUCED BY

THE NEW JERSEY ZINC COMPANY

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

160 Front Street · New York 38, N. Y.

HORSE HEAD PRODUCTS ®

For more information circle No. 60 on the Reader Service Card

Molten aluminum can't wet these parts

All these parts and fittings for aluminum die-casting and direct-chill casting are made of REFRAX® silicon-nitride-bonded silicon carbide. All are precisely formed. Yet molten aluminum can't wet them, can't harm them. That alone recommends REFRAX parts and shapes for aluminum holding furnaces and aluminum alloying furnaces (including reverberatory and induction). They are Carborundum's answer to the need for a material that can be formed into intricate parts with outstanding corrosion resistance far above normal melting temperatures.

Consider the value of these other properties in your operation: Tolerances of ±.0005 in./in.; a modulus of rupture of 5600 psi at 2450°F (even the best heat-resistant alloy melts below this temperature); and high heat conductivity that approaches that of chrome-nickel steel. Mail the coupon today for complete information.

CARBORUNDUM

Registered Trade Mark

For more information circle No. 14 on the Reader Service Card

***GET HELP** on your problem . . . write for these 3 booklets:*

MAIL THIS COUPON TODAY

Refractories Division
The Carborundum Company, Perth Amboy, N. J., Dept. R59

Please send me:

- ☐ Current issue of Refractories magazine on REFRAX
- ☐ Reprint of article in Product Engineering, Feb. '57 entitled "Nitride-bonded silicon-carbide bridges gap between metals and ceramics".
- ☐ Bulletin on REFRAX

Name_____ **Title**_____

Company_____

Street_____

City_____ **Zone**_____ **State**_____

NEW PRODUCTS AND DEVELOPMENTS

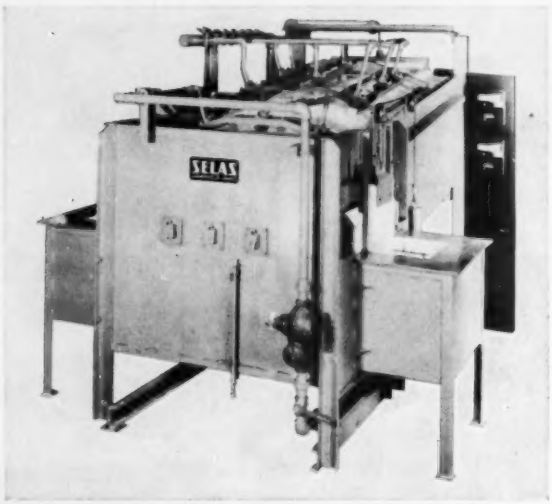
Want complete details on these announcements? Use the Readers Service Cards. You'll find them facing page 96 of this issue

LOW COST BARREL FINISHING SYSTEM

This inexpensive, precision deburring and finishing system, called Roll Barrels, is considered ideal for processing a variety of parts in small or large lots. Developed by ALMCO, QUEEN PRODUCTS DIV., KING-SEELEY CORP., the machines provide a large capacity operation in a small floor area. One operator, using two machines can continuously process up to 12 different barrels at the same time.

The machines use an open system of parallel rubber covered rollers powered by a variable speed electric motor. Small barrels with flanges are placed on and are rotated by the powered rubber rollers. Barrel rotation speed is determined by the motor speed and the size of the barrel. Nine barrel sizes are available and barrel speeds of 17 to 65 rpm are obtained.

Circle No. 239 on Reader Service Card



FURNACE FOR HIGH PURITY ALUMINUM

A two-section, dry hearth furnace, which carefully controls the melting of high purity, electrical quality aluminum, has been developed by SELAS CORP. OF AMERICA.

Both dry and wet sections of the furnace are roof-fired with Duradiant burners. This gradiation method of heating eliminates direct flame impingement and avoids contamination of the aluminum. It also provides close control of heat input. Further assurance of aluminum purity is provided by a special lining in the furnace to minimize contamination.

The melted aluminum flows from the melting zone to the holding section, without any overheating, while the pure metal separates from its oxide counterpart.

The furnace also features unusual fuel economy. During the melting operation approximately 1 cu ft of natural gas per 1-lb of aluminum melted is used.

Circle No. 240 on Reader Service Card

COATER HAS SHORTER COATING CYCLES

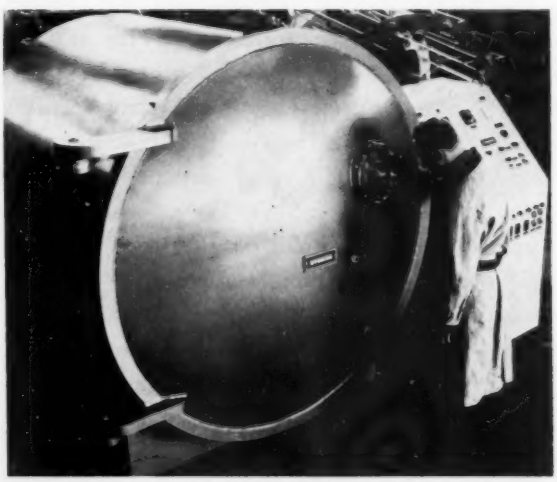
The VACUUM EQUIPMENT DIV., F. J. STOKES CORP., has introduced a 72-inch vacuum coater with a completely redesigned pumping system. The new system features faster pump-down to the metallizing pressure. This means shorter coating cycles and greater flexibility in operation and easier maintenance.

The coater has electrically interlocked push-button control over pumps and valves, automatic cross-over from rough pumping to fine pumping, and timer-controlled filament firing. The control console is located alongside the vacuum chamber, adjacent to the single sight-glass through which the operator can observe the progress of the flashing.

The pumping system has two "teams" of mechanical pump, diffusion pump and booster pump. Each team is connected independently to the vacuum chamber.

Circle No. 241 on Reader Service Card

continued on page 87



You get speedier service from the

ZINC ZONE

Central location of American Zinc plants assures prompt deliveries of slab zinc to any point in the nation.

HILLSBORO, ILL., PLANT
Prime Western, Brass Special, Intermediate, High Grade, Continuous Galvanizing Grades
MONSANTO, ILL., ELECTROLYTIC PLANT
Special High Grade, High Grade, Continuous Galvanizing Grades, Special Shapes
FORT SMITH, ARK., SMELTER
Prime Western, Brass Special
DUMAS, TEXAS, SMELTER
Prime Western, Brass Special, Continuous Galvanizing Grades

PRODUCERS OF

ALL GRADES OF SLAB ZINC
ZINC ANODES (Plating & Galvanic)
METALLIC CADMIUM
SULPHURIC ACID
LEAD-FREE and LEADED ZINC OXIDES
ZINC CARBONATE
GERMANIUM DIOXIDE
AGRICULTURAL LIMESTONE
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American Zinc Sales Company

Distributors for AMERICAN ZINC, LEAD & SMELTING COMPANY

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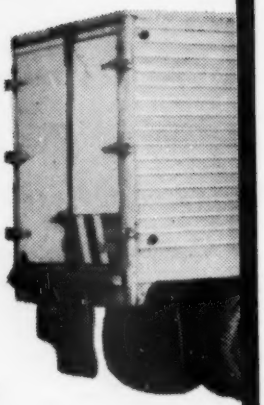
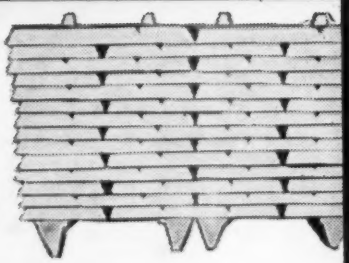
when you need zinc slabs right in your plant tomorrow*. . .



*Overnight truck delivery in eastern U. S.

and you want to conserve space & handling time . . .



Special interlock makes it easy to bulk pack and store

be sure to specify zinc slabs by GENERAL SMELTING

General's QUAKER brand Prime Western, IDEAL brand Brass Special and VICTOR brand Intermediate grade, fine quality Zinc Slabs will be in your plant tomorrow if you call today... And, as the photo shows, General's Zinc Slabs are specially produced to interlock for easy handling...made in 50 lb. slabs, packed 3000 lbs. to a bundle or to your special requirements... CALL US TODAY GArfield 3-3200

GENERAL SMELTING CO.

2903 E. Westmoreland Street \ Philadelphia 34, Penna.

For more information circle No. 31 on the Reader Service Card

PMM LETTERS

the readers' forum

SALES LEADS

I sell specialty components to original equipment manufacturers in southern California, Arizona and part of Nevada. I would like to know of "standard" die cast products which could be sold to the class of trade I cover. Would you kindly send me the list of proprietary specialties and respective manufacturers. — W.A.F.

A list of die casters who own dies and sell proprietary items has been sent. — ed.

TECHNICAL BIBLIOGRAPHY

Our company is a manufacturer of die castings. We wish to enlarge our technical library by the addition of books on the designing and building of molds and dies. Can you recommend any books dealing with the design of the die — i.e. cooling systems, location and size of gates, overflow wells, air vents, etc.

We would also like to have books on the die casting of aluminum, copper and zinc. — A. B. Factory Manager (Israel).

A list of books dealing with the die casting process in general has been sent. As far as we know, there are no books available which really teach die design. — ed.

DIRECTORIES

We have a copy of your January issue which contains a directory of the die casting industry. We wonder whether you, or any other institution publishes a similar directory of the galvanizing industry. — S. F. L., director.

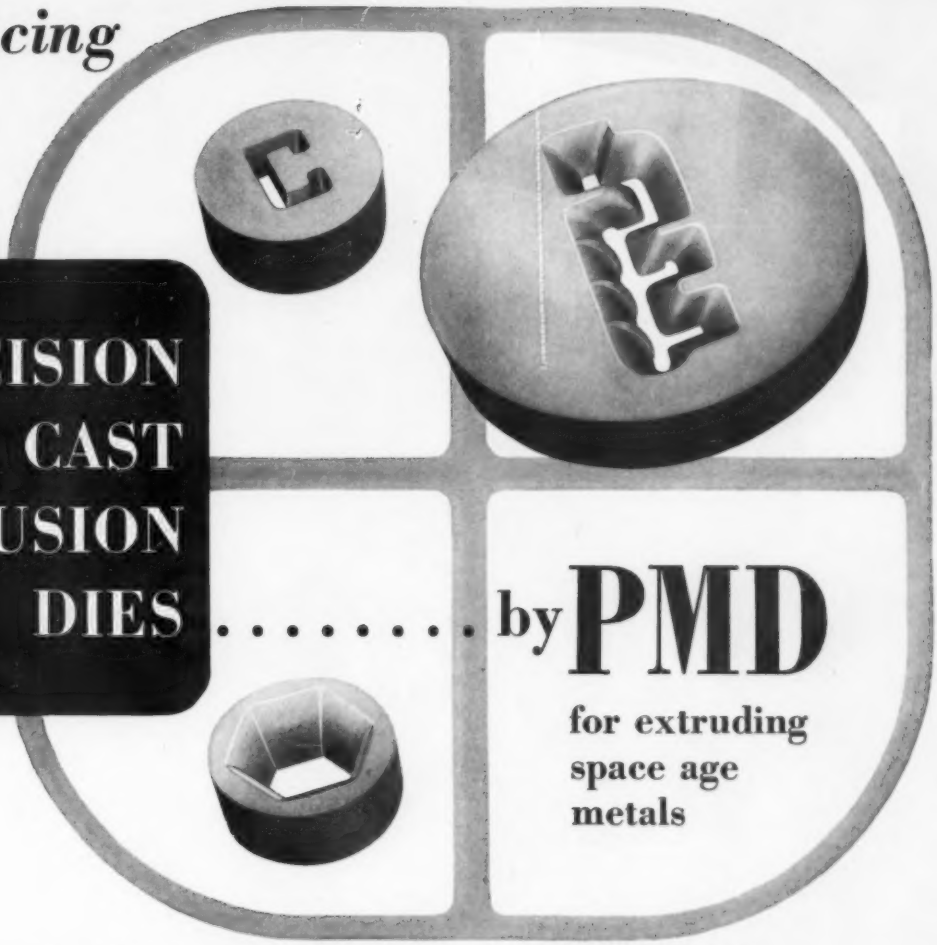
We know of no directory of the galvanizing industry. However, if one is available it can be found through the American Zinc Institute. — ed.

PERMANENT MOLDS

Are there any books, phamphlets or series of articles which deal exclusively with the design of permanent molds. I need something well illustrated. — A.H.S.

As fas as we know there's nothing available. — ed.

Announcing



PRECISION CAST EXTRUSION DIES . . . . . by PMD

for extruding space age metals

NOW, in our own Shaw Process foundry, PMD is producing precision cast dies for extruding the new space-age metals such as titanium and A286 stainless steel, as well as copper base alloys and steel alloys.

These and other hard-to-work alloys can now be extruded at temperatures of up to 2,200°F with dies precision cast by PMD in alloys such as the chromium and tungsten hot-work steels, tungsten and molybdenum high-speed steels, and cobalt base alloys.

Extruders of these tough metals report closer tolerances, longer die life, superior die performance, and trouble-free operation with precision cast extrusion dies by PMD. These high temperature dies are designed and produced to the same high standards of craftsmanship that have made PMD the symbol of quality and dependability in aluminum extrusion dies.

PMD has the men, machines and experience to solve your difficult extrusion die problems.

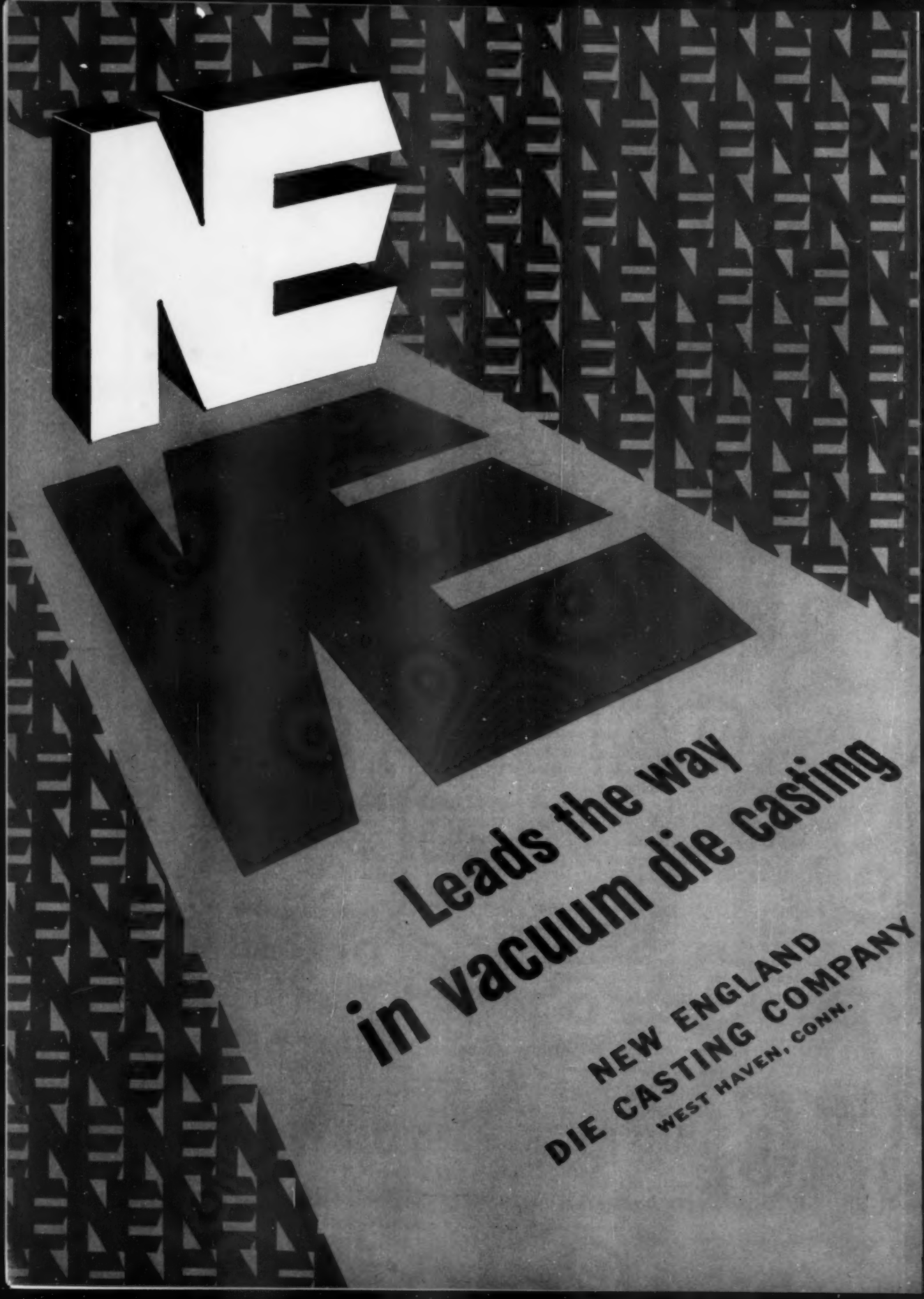
PMD SERVICES FOR EXTRUDERS AND DIE CASTERS

- **Extrusion Dies & Tools**
- **Die Casting Dies**
- **Permanent Molds**
- **D.C. Billet Casting Units**
- **Billet Molds**
- **Extrusion Plant Materials Handling Equipment**

PMD EXTRUSION DIE COMPANY, INC.

5747 BEEBE STREET, WARREN, MICHIGAN • PHONE: COngress 4-2518 (*Detroit*)

For more information circle No. 63 on the Reader Service Card


NE
VE
Leads the way
in vacuum die casting
NEW ENGLAND
DIE CASTING COMPANY
WEST HAVEN, CONN.

The effect of aging time and temperature on . . .

Mechanical Properties of 17-4PH

By F. KENNETH IVERSON*

ALLOY 17-4PH is a precipitation hardening alloy capable of being hardened to over 40 Rockwell C. It has good corrosion resistance, high ultimate tensile strength, high yield strength, and good elongation. It is characterized by a relatively low aging temperature which helps prevent distortion during heat treatment. The alloy can be cast and machined in the solution-heat-treated condition and then fully hardened with little or no danger of dimensional changes.

COMPOSITION

Both composition and hardening must be carefully controlled to prevent formation of delta ferrite and to insure complete transformation of the austenite to martensite. Both retained austenite and delta ferrite lower the mechanical properties.

Because this alloy is so sensitive the composition must be watched carefully. Adjustments must be made to compensate for pick-up or loss of alloying elements during melting. Table I gives the preferred specifications for the best mechanical properties, the adjusted composition to allow for remelt losses or pick-up, and notes on the effect of each of the alloying agents.

HEAT TREATMENT

Homogenization. Under some conditions of unbalanced chemistry and possibly incorrect melting and casting practice, the copper in 17-4PH will tend to segregate at the grain boundaries. Since the copper is the dispersion hardening agent, desirable mechanical properties can only be secured if the copper is in solid solution prior to aging. Homogenization may, therefore, be necessary by soaking the castings at 2100°F for 1½ hours followed by air or oil cooling. More balanced chemistry and lower copper content may make this treatment unnecessary.

Solution Treatment. Solution treatment is designed to put the dispersion hardening phase in solid solution and to refine the cast grain structure. A solution treatment at 1900°F for ½ to one hour followed by oil quenching gives the most desirable results. In some cases where the castings are non-magnetic and tensile properties are low, a solution temperature of 1500°F to 1600°F will reduce the amount of carbide which goes into solution in the austenite. This will reduce the stability of the austenite so that satisfactory transformation will occur and higher tensile properties will be obtained.

*CANNON-MUSKEGON CORP.

This is a condensed report of a research project carried out by the Cannon-Muskegon Corp. for the Investment Casting Institute. It is the first in a series of these reports which will be published in PRECISION METAL MOLDING.

Precipitation Hardening. Present specifications call for aging 17-4PH castings at 875°F to 975°F for one hour, followed by air cooling.

To determine the effect of aging time and temperature, 36 test bars, keel gated, were made from each of two heats with the compositions shown in Table II. The metal was melted in an indirect arc furnace, and no alloying additions were made during remelt. Test bars were poured at 2900°F into ethylsilicate molds, preheated to 1600°F. Bars were homogenized at 2100°F for 1½ hours, air cooled and solution treated at 1900°F for ½ hour, then oil quenched. All test bars

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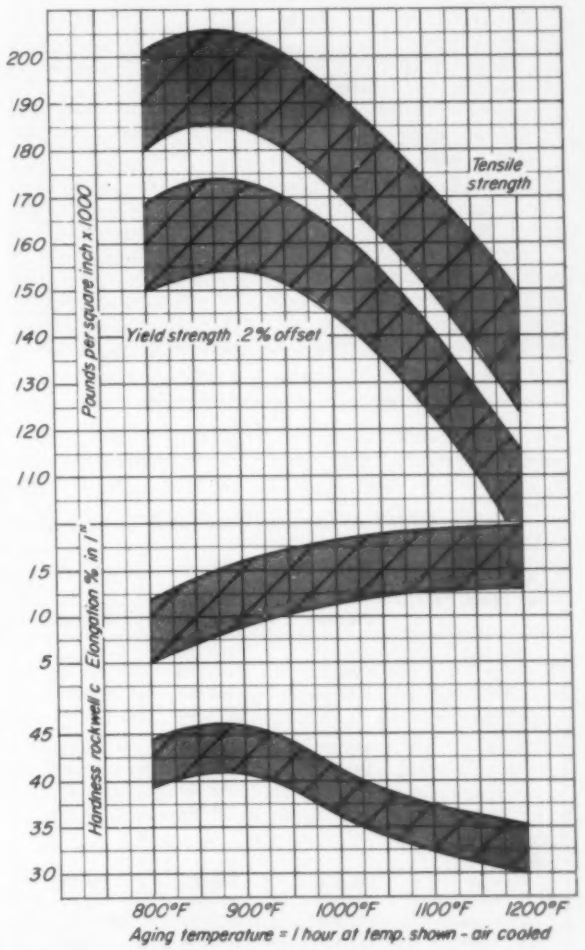


FIGURE 1. Summary of results of testing 17-4 PH.

TABLE I

Recommended Analysis for 17-4PH, Specification and Remelt Analysis

Element %	Specification %	Remelt Specification		Remarks
		Arc %	Induction %	
C	0.06 max	0.04 max	0.05 max	Tends to stabilize austenite
N	0.05 max	0.035 max	0.05 max	Tends to stabilize austenite
Si	0.60-0.90	0.70-1.00	0.70-1.00	Provides good fluidity. Prevents excessive loss of both chromium and columbium through oxidation. Aids in formation of delta ferrite if too high a Si content.
Mn	0.30-0.70	0.40-0170	0.40-0.70	Stabilize austenite
Cr	15.5-16.75	14.7-16.8	15.7-16.8	Strong delta ferrite former, especially when Cr content is above 17.0%.
Ni	3.25-4.25	3.25-4.25	3.25-4.25	Strong austenite stabilizer. Above 4.5% the alloy does not respond to heat treatment well.
Cb + Ta	0.15-0.40	0.25-0.40	0.25-0.40	May inhibit over-aging tendency of alloy. Seems to provide longer lasting high-temperature strength above 700°F. Has some tendency as ferrite former.
Cu	3.00-4.00*	3.00-4.00	3.00-4.00	Responsible for the precipitation hardening properties of the alloy. Above 4.0% Cu tends to promote under-bead cracking in welds and dendritic segregation. Optimum range for investment castings not determined, may be as low as 2.2%.

*Future work may lower this specification

TABLE II

Composition of Heats Used for Casting Test Bars

	Cb free	With Cb
Cb + Ta	< 0.05	0.27
C	0.028	0.034
Mn	0.68	0.59
Si	0.69	0.60
Cr	16.24	15.92
Ni	3.44	4.13
Cu	3.60	3.58
N	0.030	0.032
P	0.008	0.017
S	0.015	0.012

were machined to 0.252" standard tensile test specimens and aged. The results are shown in Table III.

Results of the admittedly limited testing show:

- For the best combination of tensile strength and ductility, an aging temperature of 900°F to 975°F should be used.
- Addition of columbium prevents loss of properties due to over-aging.
- An aging time of one hour appears best for the most consistent results. At 900°F, significant over-aging did not occur until test specimens had been aged more than 4 hours.

A summary of results of the above tests, plus about 70 additional tensile tests, is given in Figure 1. The curves are applicable to alloys with or without columbium.

TABLE III

Effect of Aging Time and Temperature on the Mechanical Properties of 17-4PH

Aged 1 hr. at temp. °F	Tensile Strength psi		Yield Strength psi		Elongation % in 1 in.		Hardness Rockwell C	
	Cb free	With Cb	Cb free	With Cb	Cb free	With Cb	Cb free	With Cb
As cast	161,000	154,600	142,800	112,000	2.7	3.5	38.2	—
800	199,200	190,700	161,100	155,700	6.8	12.7	42.0	42.7
850	200,900	200,900	156,800	156,100	7.7	9.0	44.0	45.3
900	197,700	200,300	163,500	154,700	11.7	14.7	42.5	43.7
950	182,300	197,000	161,000	157,400	13.0	13.0	41.5	42.0
1000	185,700	164,800	159,300	141,000	13.5	14.0	37.5	38.5
1050	141,800	163,100	132,000	150,800	16.0	16.0	34.5	34.7
1100	156,500	162,000	121,700	143,200	16.0	15.7	34.0	34.0
1200	152,500	146,600	130,000	125,100	12.0	15.0	32.0	30.0
Aging Time at 900°F								
½ hour	200,800	200,500	155,700	158,000	10.0	6.7	42.7	45.2
1 hour	197,700	200,300	163,500	154,700	11.7	14.7	42.5	43.7
2 hours	201,800	193,600	156,700	153,300	11.7	13.3	44.3	45.2
4 hours	171,100	188,100	142,000	156,200	16.0	9.0	37.5	42.3
8 hours	164,400	—	140,900	—	14.0	—	36.5	—

Vacuum-cast steels . . .

An Improved Engineering Material

CAN the mechanical properties of high alloy tool steels, high temperature steels, and special alloys be improved? Apparently yes. How? By so-called vacuum casting in a consumable-arc melting furnace.

Experimental and semi-production melts of high alloy tool steels showed that such properties as fatigue strength, ductility, impact strength and others could be materially raised by melting and casting the steel under reduced pressures.

Vanadium-Alloys Steel Co. was so convinced of a potential market for these improved steels that they designed and have just completed the installation of one of the largest consumable-arc vacuum furnaces in the country. Not only is the furnace big, it's highly flexible.

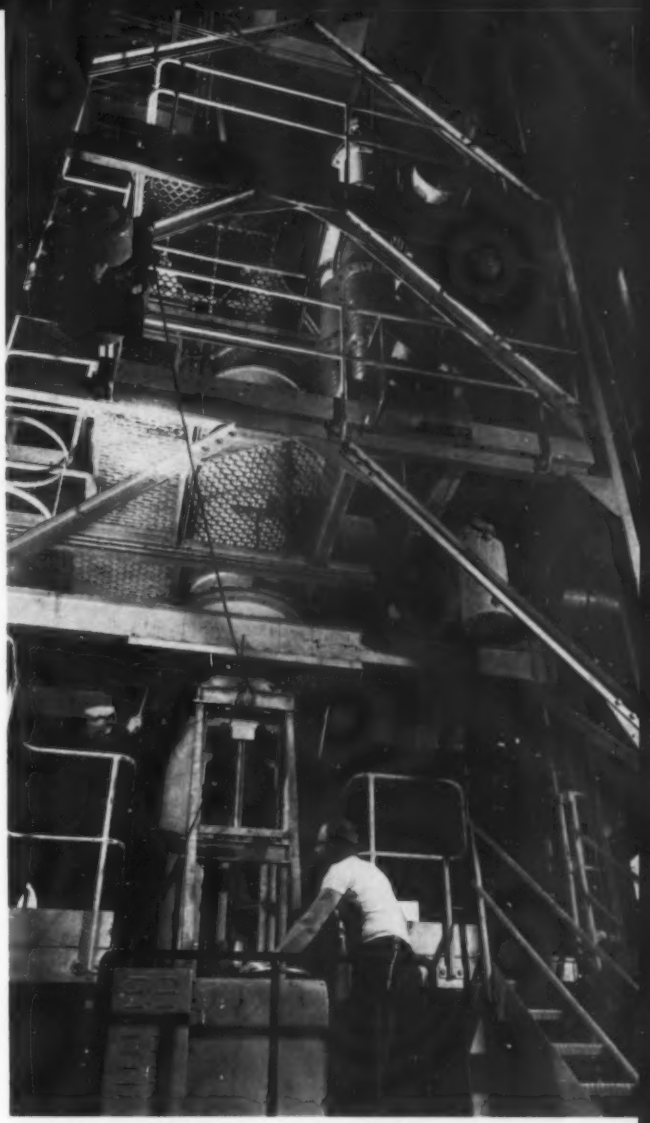
Most furnaces of this general type operate at an ultimate pressure of from 50 microns up. This unit was designed to operate at under 5 microns and production runs are being made consistently at pressures under 0.3 microns.

WHAT DOES IT MEAN?

To the consumer it means that for steels in the range of 260,000 to 300,000 psi ultimate tensile strength, the average ductility, as measured by elongation and reduction in area, and the impact strength are both increased about 50%. At the same time the fatigue strength is greatly increased. While improvements are found in mechanical properties in both the longitudinal and transverse direction, the most notable change is in the transverse direction. This comes about from the difference in manner of solidification and cooling of the ingot.

The ordinary ingot is melted in air and then cast in a steel ingot mold. Cooling is from the outside in to the center and as the steel cools and shrinks the center is fed from a reservoir of metal held in the hot-top. As a result, the structure is columnar with a concentration of impurities in the center. Further, the rather slow rate of cooling allows segregation to take place, resulting in non-uniform properties in the ingot. Hot and cold working combined with heat-treatment can do much to break up the cast structure, but there are still problems of segregation, inclusions, porosity, and lower mechanical properties in the transverse direction.

Now when this same steel is melted under reduced pressure and chilled immediately in the water cooled mold, a fine grained, non-columnar structure results. The action of the arc breaks up and floats non-metallic inclusions on the surface of the molten metal pool. These impurities, for the most part, remain on the top of the ingot.



VANADIUM-ALLOYS' new vacuum melting furnace.

By melting at reduced pressures, almost all of the dissolved gases, notably hydrogen, oxygen and nitrogen, are removed. At the same time, the very high temperature of the electric arc, 5000°C to 8000°C, in combination with the very low pressure, permit the dissociation of many of the intermetallics, particularly the oxides, which would otherwise be retained in the ingot as inclusions.

The improvements which have been noted so far relate to wrought shapes. Little is known at present about the improvement, if any, when these vacuum melted steels are remelted and cast as investment castings, for example. But, starting with a cleaner, fully degassed metal, there can be little doubt that investment cast parts will have superior mechanical properties, provided remelting is done carefully.

In the group of so-called super alloys, the use of vacuum melted stock for investment castings should be particularly beneficial. These alloys are highly susceptible to notch failures arising from slag inclusions and their mechanical properties are materially altered by dissolved gases.

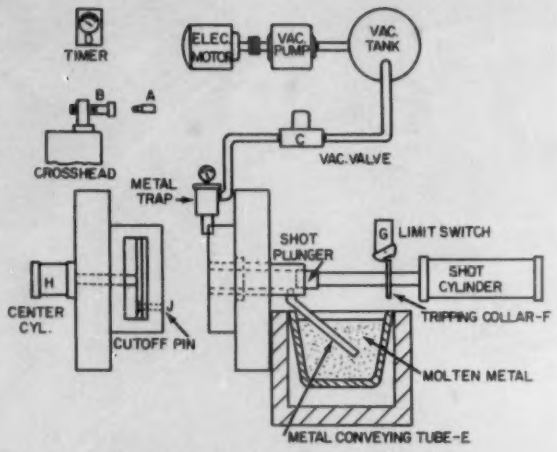


FIGURE 1. Typical Set-up.

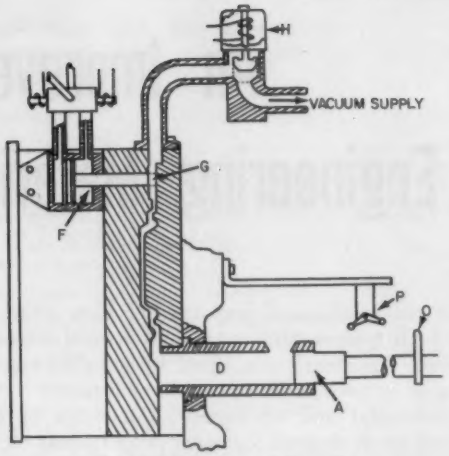


FIGURE 2. Vacuum Channel.

Vacuum die casting lets you use . . .

One Casting Machine for Aluminum or Zinc

VACUUM DIE CASTING has proven itself. Certain types of jobs which couldn't be done before or which showed an exceptionally high reject rate are being produced economically with the aid of vacuum. This is true of both zinc and aluminum.

But is the use of vacuum limited to those troublesome jobs? Cleveland Automatic Machine Co. doesn't think so. They have adopted the Morton vacuum system, refined and improved it. Why? Because with this system it is easy to make a cold chamber machine self ladling. Also with this system cold chamber machines can be made fully automatic. And finally, the added cost of installation and the added cost of die making is about the lowest for any vacuum system which is available now.

CHANGE-OVER IS SIMPLE

But the big feature, this company believes, is in making one machine capable of casting either zinc or aluminum simply by changing the melting pot. Disconnect the feed tube which runs from the pot of molten metal to the die casting machine, roll out one furnace and put in another and the change from metal to metal is made. A look at a typical set-up (Figure 1) shows why this can be done.

The only modification to change a machine equipped with hand ladling to automatic ladling is to turn the shot sleeve 180° so that the pouring hole faces down. A melting pot is positioned below the sleeve and a cast iron pipe, coated inside and outside with a dense silicate material runs from below the surface of the molten metal to the pouring hole. An additional timer is put on the machine to regulate the shot size.

Except for the die, the balance of the vacuum system is: a 41 cu. ft. per min. vacuum pump, an 80 gal. surge tank, vacuum valves and the necessary piping.

The die, of course, must be built originally, or modified to operate under reduced pressure. Good gating and risering must be employed and a vacuum channel must be provided as shown in Figure 2. Each cavity of the die requires a metal shut off pin built into the ejector half of the die. This pin may be operated by a separate air or hydraulic cylinder or may be operated by the ejector system. A typical, single cavity die is shown in Figure 3 and a multiple cavity die in Figure 4. In both of these figures, the cut-off pin is actuated by the machine's hydraulic ejector cylinder.

HOW CASTING IS DONE

Let's follow a typical cycle on a Cleveland 400 ton machine making the aluminum bezel shown in Figures 5 and 6, using a single cavity die. The machine closes and locks, then the vacuum valve is opened. The capacity of the vacuum system is great enough to pull a vacuum of about 29.6 in. of mercury in the die cavity without any gaskets or seals. As the pressure is reduced, aluminum is drawn into the shot sleeve. When the right amount of metal, in this case 9¼ oz., has been sucked into the sleeve, the auxiliary timer trips the injection piston mechanism and the shot is made in the usual manner. The time required for drawing the metal from the pot into the cylinder is 1/3 second, considerably faster than hand ladling. Vacuum is maintained on the cavity during the entire injection time, and when the die is filled and metal has passed into the vacuum channel in the die, the

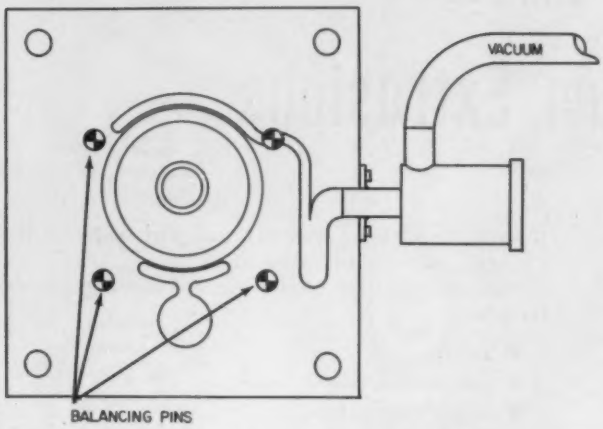


FIGURE 3. Single Cavity Die.

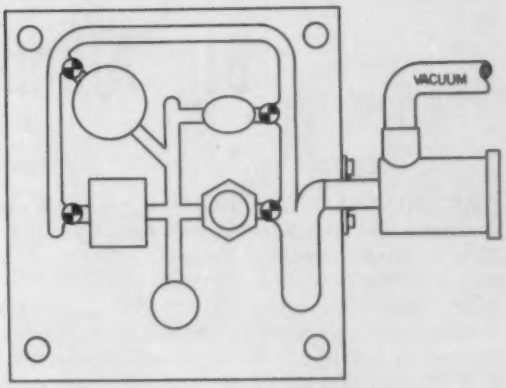


FIGURE 4. Multiple Cavity Die.

cut-off pin closes off the channel. After this, the cycle is standard.

In a casting of the kind shown and with the machine on semi-automatic operation, but with automatic ladling, a consistent speed of 300 shots per hour can be maintained. Lubrication is automatic after each shot and with this die only the ejector half has to be lubricated.

WHAT ABOUT COST?

Now how much extra does all of this cost? On the first installation the price tag of a hand ladling vacuum system is $3430 extra. However, each vacuum pump and tank can handle at least three machines and probably four. For the additional two or three machines the extra cost is $2630 per machine. This added cost does not include the cut-off pin and its operating mechanism, since these are parts of each die.

Die costs are also somewhat higher for vacuum operation. On new die construction this will run from $200 to $400, depending on the number of cavities. On old die remodeling, the cost is about $600 per die.

Actual operating costs of the vacuum system are so low that piece costs do not show any increase from this source. The added die costs must be considered, however.

The higher, more uniform operating rate of the machine when vacuum and automatic ladling are used gives such improved quality and production that the piece cost is lower. Automatic lubrication and more complete filling of the die cavity result in a much lower reject rate.

It would seem, then, that when the increased costs are balanced against increased production, the advantage is very definitely in favor of vacuum die casting. Certainly this is true when casting aluminum. With zinc, the chief advantage is in not having to purchase separate machines and with this method, zinc castings are produced at much higher injection pressures than can be obtained in hot chamber machines.

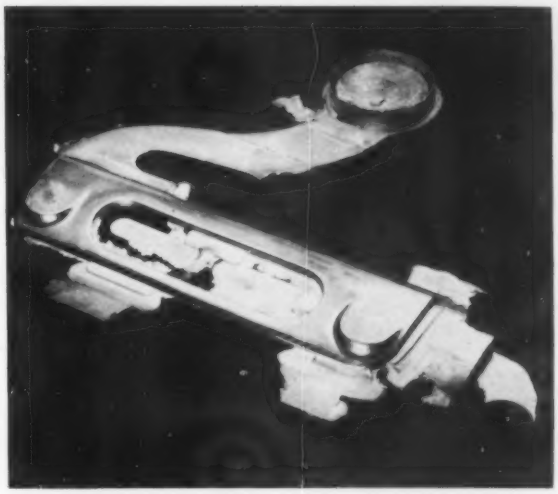


FIGURE 5. As-cast Aluminum Bezel.

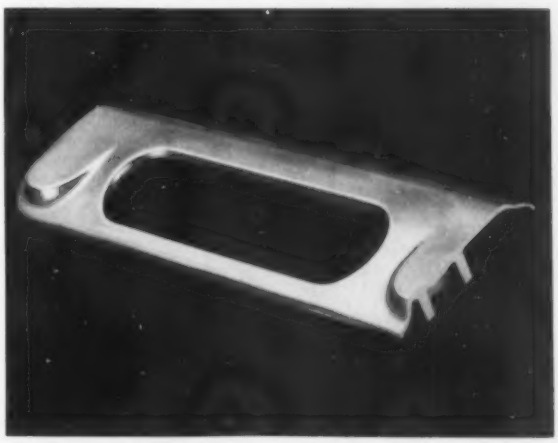


FIGURE 6. Finished Aluminum Bezel.

Extend your design potential with . . .

Big Aluminum Extrusions

ALUMINUM EXTRUSIONS are known to most engineers and designers. In one operation, it is possible to form a complex shape by placing the metal only where it is needed. Extrusions thereby eliminate bulky assemblies made up by joining, welding, or riveting rolled sections. In thousands of products for decorative, functional, and structural applications, aluminum extrusions offer a freedom of design unobtainable with other metal working processes.

Giant extrusion presses, such as the 8000 and 12,000 ton hydraulic units at the Harvey Aluminum plant in Torrance, Calif., are extending the design advantages of aluminum extrusions. Larger sections, longer lengths, more intricate configurations, and greater cross-sectional area are now possible.

Designing big aluminum extrusions is about the same as for conventional extruded shapes, except that size limitations have been broadened. The present maximum cross-sectional dimensions for the average-shape big extrusions are governed by a circumscribing circle approximately 32 inches in diameter. Tolerances published by the Aluminum Association are standard mill tolerances for big extrusions. For many shapes, tolerances closer than standard are possible.

Big aluminum extrusions replace sections now assembled from smaller components. When several sections are combined, assembly and part costs are decreased and weight is reduced.

Aluminum shapes producible on the big presses include:

- Tube.
- Integrally-stiffened panels.
- Stepped extrusions.
- Structural sections, such as I-beams, H-beams, channels, angles, tees, zees.
- Bar and rod.
- Semi-hollow and hollow.
- Solids.
- Special configurations.

For complicated shapes, softer alloys can be extruded more easily than high-strength alloys because of the relatively low extrusion pressures required. Thinner shapes, unbalanced cross-sections, and deep channels with a ratio of depth to width of 6 to 1 and up can be extruded on the heavy presses.

Large diameter extruded tube can be made up to an I.D. of 25 inches. Wall thicknesses vary, depending on the length and alloy.

Structural aluminum shapes can be extruded on the big presses comparable to the largest fabricated

I SOLID SHAPES

STANDARD MANUFACTURING LIMITS

Circumscribing Circle Diameter†, Inches	Minimum Thickness, Inch* Alloys 3003 6061 6062 6063	2014 6066	2024‡ 7001‡ 7075‡ 7178‡
Col. 1	Col. 2	Col. 3	Col. 4
10 to (not incl.) 13	0.109	0.125	0.156
13 to (not incl.) 16	0.125	0.156	0.187
16 to (not incl.) 19	0.140	0.171	0.250
19 to (not incl.) 25	0.156	0.187	0.375

*Applicable to mean thickness if unequal plus and minus tolerances are specified.

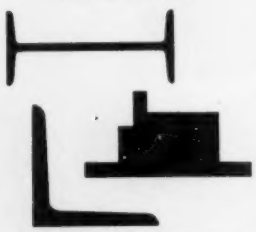
†The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the shape.

‡The following limitations will apply to corner and fillet radii for alloys 2024, 7001, 7075 and 7178:

Alloy 2024: Minimum corner and fillet radii of .010".

Alloys 7001, 7075 and 7178: Minimum corner radii of .031" for sections having a thickness GREATER than .124". Minimum corner radii of .016" for sections having a thickness LESS than .125". The minimum fillet radii is .031".

TYPICAL SECTIONS



II HOLLOW SHAPES

STANDARD MANUFACTURING LIMITS

Circumscribing Circle Diameter†, Inches	Minimum Thickness, Inch* Alloys 3003 6061 6062 6063	2014 6066	2024‡ 7001‡ 7075‡ 7178‡
Col. 1	Col. 2	Col. 3	Col. 4
10 to (not incl.) 13	0.125	0.156	0.187
13 to (not incl.) 16	0.140	0.171	0.250
16 to (not incl.) 19	0.156	0.187	0.375
19 to (not incl.) 25	0.171	0.250	0.437

*Applicable to mean thickness if unequal plus and minus tolerances are specified.

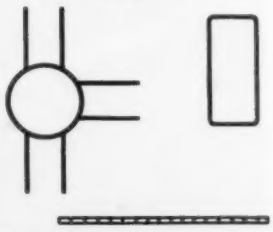
†The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the shape.

‡The following limitations will apply to corner and fillet radii for alloys 2024, 7001, 7075 and 7178:

Alloy 2024: Minimum corner and fillet radii of .010".

Alloys 7001, 7075 and 7178: Minimum corner radii of .031" for sections having a thickness GREATER than .124". Minimum corner radii of .016" for sections having a thickness LESS than .125". The minimum fillet radii is .031".

TYPICAL SECTIONS



III PANELS

STANDARD MANUFACTURING LIMITS

Extruded Form	Circumscribing Circle Size (Flat), Inches†	Minimum Thickness, Inch* Alloys 3003 6061 6062 6063	2014 6066	2024‡ 7001‡ 7075‡ 7178‡
	Col. 1	Col. 2	Col. 3	Col. 4
—	9 to 25½	.062 to .187	.072 to .213	.094 to .600
^	14 to 36	.062 to .187	.072 to .213	.094 to .600
⊓	18 to 51	.062 to .187	.072 to .213	.094 to .600
◇	21 to 57	.062 to .187	.072 to .213	.094 to .600
⬡	21 to 60	.062 to .187	.072 to .213	.094 to .600

*Applicable to mean thickness if unequal plus and minus tolerances are specified.

†The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the shape.

‡The following limitations will apply to corner and fillet radii for alloys 2024, 7001, 7075 and 7178:

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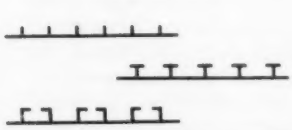
TYPICAL SECTIONS



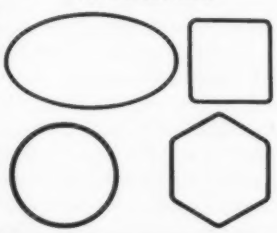
IV TUBE

STANDARD MANUFACTURING LIMITS

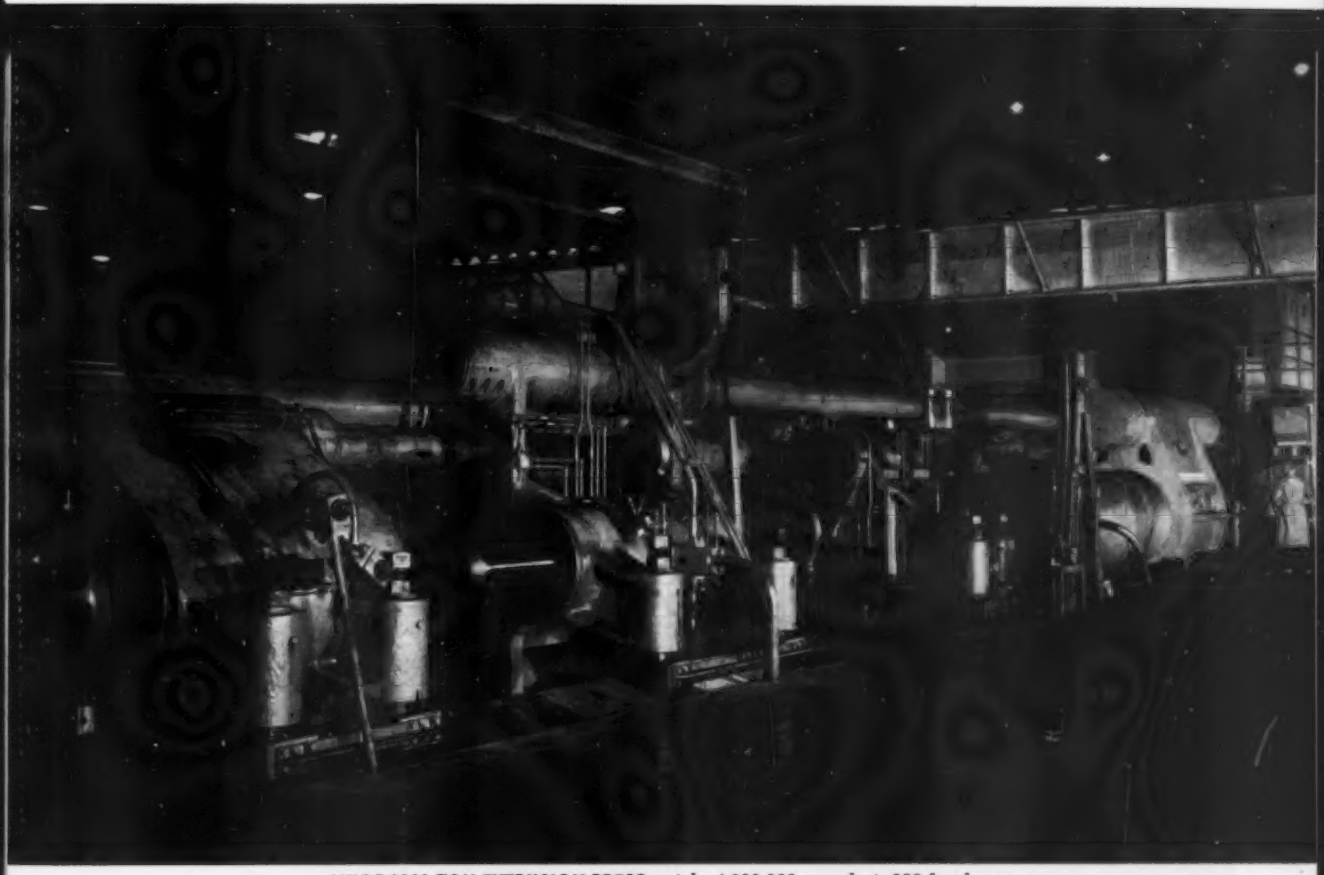
Inside Diameter Inches	Minimum Thickness, Inch* Alloys 3003 6061 6062 6063	2014 6066	2024 7001 7075 7178
Col. 1	Col. 2	Col. 3	Col. 4
7 to 9¾	.093 to .153	.125 to .184	.156 to .345
9¾ to 11½	.093 to .153	.125 to .184	.156 to .345
11½ to 15¾	.093 to .153	.125 to .184	.156 to .345
15¾ to 25	.093 to .153	.125 to .184	.156 to .345

*Applicable to mean thickness if unequal plus and minus tolerances are specified.

TYPICAL SECTIONS



MANUFACTURING LIMITS for typical aluminum shapes being produced.



HUGE 8000-TON EXTRUSION PRESS weighs 4,000,000 pounds, is 288 feet long.

steel sections. Generally, they can be used whenever rolled steel shapes are used, with the advantages of better strength-to-weight ratio, custom design, reduced fabricating costs, and maximum resistance to corrosion. These big structural shapes are available in heat-treated lengths up to 80 feet. A typical aluminum I-beam section can be extruded on the 12,000 ton press with a web of 24 inches deep.

Integrally-stiffened panels, in which the skin and stiffening elements are extruded in one piece, offer broad new design possibilities. These wide sections can be extruded flat or extruded in a V or U form and then flattened to produce parts wider than the diameter of the extrusion die. Shapes can also be made as a tubular extrusion and then flattened to make a wide section. On the 12,000 ton press, Harvey can extrude panel sections in widths up to 60 inches.

Stepped extrusions, produced by changing the die after interrupting the initial extruding process, usually combines two or more sections in a single extruded length having a large end integral with a forward end of a smaller cross section. Stock left on the section for machining is negligible compared to the number of man hours and the amount of metal that would otherwise be lost if the entire shape had to be milled out.

Aluminum alloys, both cold worked and heat-treatable, being extruded on the large presses include EC, 3003, 2014, 2024, 6061, 6062, 6063, 6066, 7001, 7075, 7079, and 7178. Cold-worked alloys are usually supplied in the annealed or as-fabricated temper. Heat-treatable alloys are furnished in several tempers covering a range of mechanical properties from the annealed "O" temper to heat treated, aged T6 temper.

INTEGRALLY-STIFFENED panels offer broad possibilities.

DESIGN FOR
DIE CASTINGS

Don't machine away profits when you can . . .

Die Cast Parts at One-Fifth the Cost

ARE YOU machining away profits? That's what the Allen Electric & Equipment Co. was doing until they switched to a die casting for the cell block on their Model E-1206 combustion analyzer. Originally, the part was machined from ½" x 2" aluminum bar. The cost, as originally designed was reasonable at 50 cents each. But, the analyzer was erratic in operation.

Allen engineers solved the problem by tightening tolerances on the cell block. Now, the analyzer was consistent, but to machine the extremely close tolerances pushed costs to $2.50 per part.

To rid themselves of this high cost, the company set out to find another method of manufacture that would produce a part equal to the machined block in function, yet be low in cost.

The analyzer measures thermal conductivity of exhaust gases to determine the gas-to-air ratio. The cell block, a part of the tail pipe analyzing unit, receives the exhaust gases, does its figuring, and electrically relays the facts about the gases to the receiver inside of the car.

To perform this function, the cell block has to meet these requirements:

1. No porosity. Any porosity would allow the gases

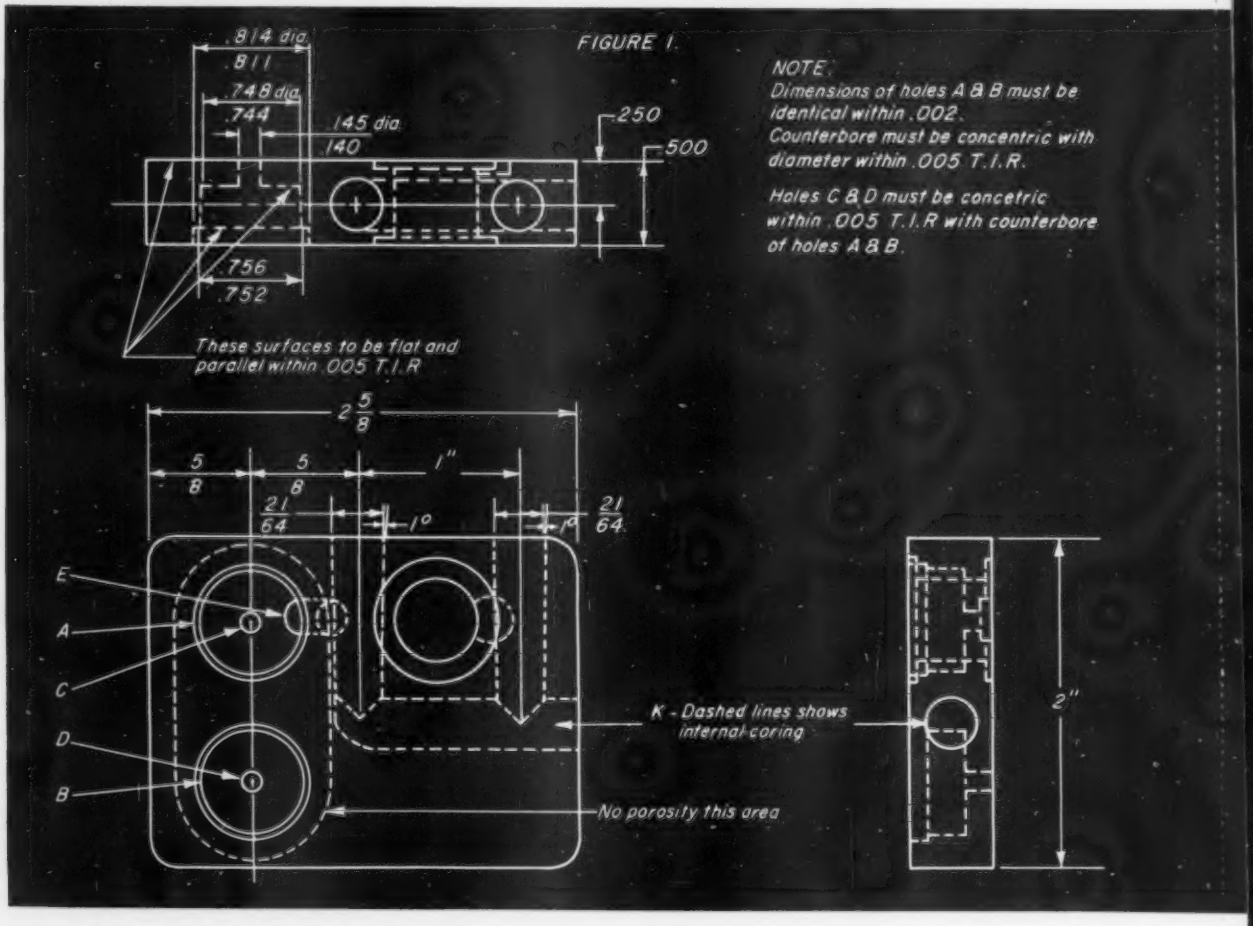


FIGURE 1.

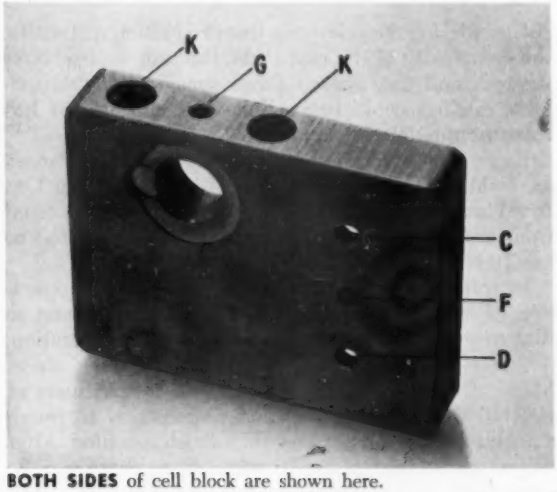
NOTE:
Dimensions of holes A & B must be identical within .002.
Counterbore must be concentric with diameter within .005 T.I.R.

Holes C & D must be concetric within .005 T.I.R with counterbore of holes A & B.

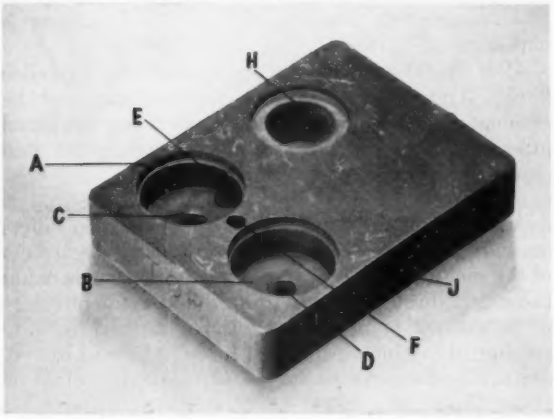
to impregnate the part, affecting the accuracy of the meter.

2. A .500 thickness must be maintained throughout the part.
3. The surfaces indicated for holes A & B (Figure 1,a) must be flat and parallel within .005 T.I.R.
4. Holes A & B have to be held to .756/.752 with a depth of .250/.247 and the dimensions of the two holes have to be identical to each other within .002.
5. The counterbore of holes A & B has to be held to .813/.812.
6. The .813/.812 diameter of the counterbore must be concentric with the .756/.752 diameter of holes A & B within .005 T.I.R.
7. Holes C & D, .150/.145 diameter, must be concentric within .005 T.I.R. with the diameter of the counterbore of holes A & B.
8. Light weight.

The only alternative to machining the cell block was to cast it. A study of various casting methods showed that only a die casting could meet the requirements, with one exception. The counterbore of holes A & B couldn't be cast to the specified .813/.812. Engineers found that this dimension could be loosened to .814/.811 without affecting the function of the cell block.



BOTH SIDES of cell block are shown here.



Working closely with the engineers at Allen, New Products Corp. was able to die cast the part and meet all of the requirements. All but 5 holes, E, F, G, H & J, are cast into the part. Even the intricate passageway, K, was cored. Die casting the cell block reduced the price from $2.50 each to below the original cost of 50 cents.

The difference is in the machining required:

Machined Cell Block

1. Cut to length from rectangular aluminum bar.
2. Sand 8 sides for finish.
3. Drill and counterbore holes A & B.
4. Drill and ream 6 holes.
5. Drill 1 hole.
6. Drill and tap 1 hole.
7. Black anodize.

Die Cast Cell Block

1. Drill 3 holes.
2. Tap 5 holes.
3. Black anodize. (This serves to seal in any gases in the part.)

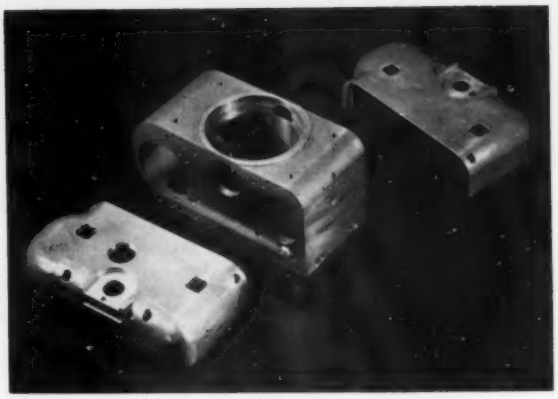
In addition, the die casting has these added features:

- Better appearance by die casting the rounded corners. This was not done on the machined part because it would have added to the high cost.
- Consistent holding of tolerances. The human element in critical machining was eliminated, as was the need for close quality control.
- No rejects. The cell blocks are purchased from the die caster ready for assembly, and of consistent good quality.
- Fast delivery. The cell blocks can be die cast, machined, and delivered faster than an equivalent number of parts could be machined from bar.

The only finishing necessary is to remove burrs resulting from machining, stamp the letters "TOP" in the casting, and black anodize. Although some may think it more practical to cast in the lettering, it is sometimes more economical to stamp it. Here is a case in point. To cast in the lettering "TOP", either recessed or raised, would require a loose piece or slide in the die. To do this adds to the die cost. In addition, it slows the die casting operator down since either the loose piece, or the slide, require hand operation.

ASSEMBLED cell block is at extreme left.

Investment Cast Camera Body



WHEN you ride in an airplane traveling at about Mach 2 and want a picture of the ground going past, a Brownie won't do. Neither will a standard aircraft camera. For one thing, there isn't room for the bulky equipment common to many aircraft cameras. Weight is also important, as a pound of fuel may be a lot more important than an extra pound of camera. Then, of course, there's the problem of gathering in enough light at the very fast shutter speeds to get a picture.

But we aren't concerned with optics. The functioning of the camera is only of importance in how it influences the accuracy and intricacy of some of the component parts; and it's a lot of influence.

Because a lot of machining has to be done on the camera bodies, a free machining alloy has to be used. When this is coupled with light weight and with both finish and corrosion resistance, there's only one answer — aluminum.

To get the shape on the body and the two covers that is needed, a casting of some sort seemed to be indicated. Of course, the three parts could be hogged out of bar stock, but the waste of metal is terrific. What's left? Well sand casting, of course, die casting, permanent mold casting, and investment casting. Let's take a quick look at each one.

SAND CASTINGS

Not at all satisfactory. A heavy skin had to be left all over for machining. To keep the weight down, the walls have to be thinner than can be sand cast.

As for dimensional accuracy, a sand casting just couldn't come close, and the variation from casting to casting was so great that the machining of each part became a separate job.

Details? they had to be machined in. In other words, a sand casting was simply a crude imitation of what was really needed. And even when a sand cast case was fully machined, it would warp. There was no assurance that even when a sand cast case was fully machined, straightened, and heat treated that it would stay that way.

So how about . . .

DIE CASTINGS

Fine, if production is high enough to justify the high cost of tooling. The castings made by this process are the most nearly complete and the most stable of any. When and if the production of any model is high enough, then die casting is the only logical fabricating process. But right now, production is so low that the cost of dies can not be justified.

Then there's . . .

PERMANENT MOLD CASTING

Just about all of the objections that apply to die casting apply here. High cost tooling for such a complex part and, in this case, without the accuracy, reproducibility and dimensional stability of die castings. Surface finish on a permanent mold cast case, while pretty good, still left a bit to be desired. The economies of the process, for the production, just weren't good enough.

The best production method then is . . .

INVESTMENT CASTING

Considering the relatively low production quantities, the complexity of the cast parts, the thin wall sections desired, and the surface finish specifications, investment castings could be produced for at least 25% less than the next closest competitor.

Except for a very few critical dimensions, tolerances are held to $\pm$ 0.004"/in. by the Liebros Casting Co., Inc. Parts are cast in 356 aluminum and are delivered from the foundry stress relieved and heat treated to the T6 condition.

In spite of the care involved in the casting operation, there is some warpage during heat treatment so that straightening becomes another foundry operation.

When the castings are received, machining starts. Many of the dimensions must be held to tolerances of $\pm$ 0.001 or less, so the normal sequence is to rough machine, stress relieve, and then finish machine. After the rough machining and stress relieving there may be secondary warpage, so a second straightening operation is included. When finally machined, flatness is within $\pm$ 0.0005.

After machining, all castings receive black anodize finish. When radio frequency interference must be eliminated, the grooves for the gasket are machined after anodizing. The outside of the castings get zinc chromate primer and gray enamel paint.

Because of the great amount of machining that is required on these parts, there is practically no difference in the percentage of rejected parts, regardless of the method of production. The saving that is made is entirely through the ability of the investment caster to produce a more nearly finished part so that the amount of machining to finish is less. As noted above, the saving through the use of investment castings is about 25%.

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Exceptional rigidity of this four corner lock-up and support provides unusual platen stability.

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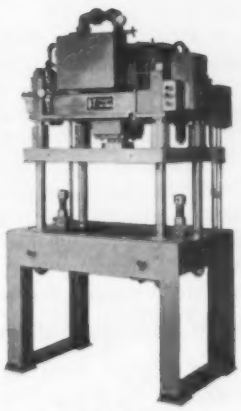
You are invited to use our Die Casting Research Center for the furtherance of die casting techniques. See what Variable Shot Control & Vacuum does to produce superior castings.



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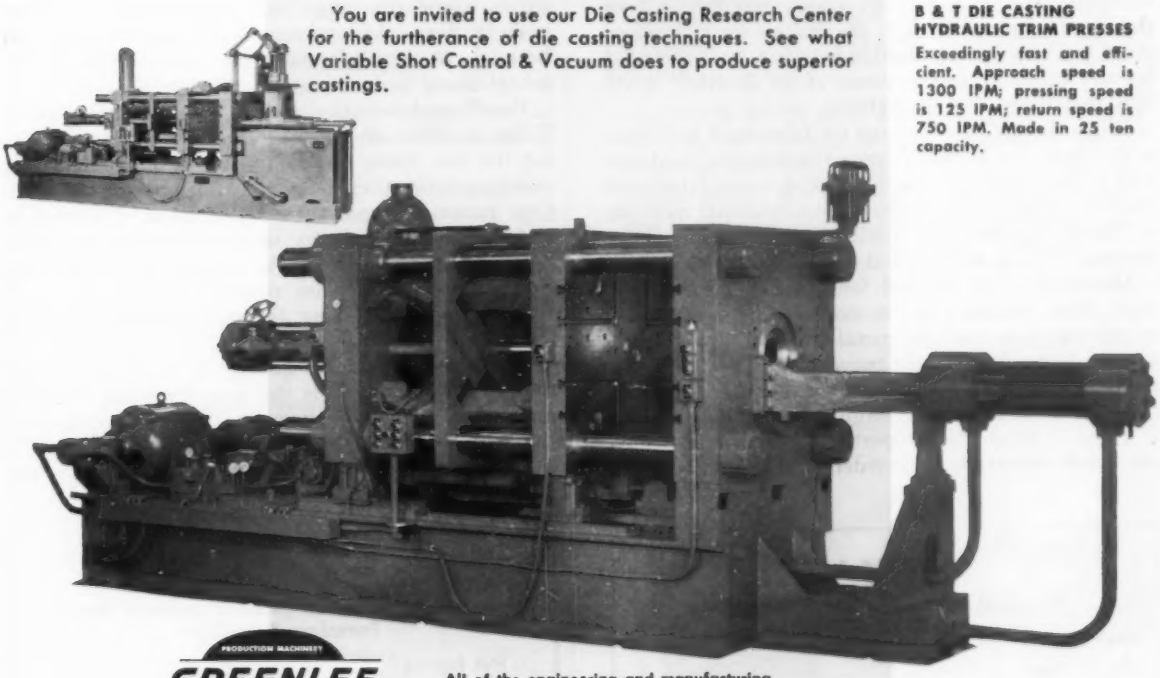

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Powder Metallurgy of Beryllium

BERYLLIUM has become important in missiles, guidance systems, and space vehicles because of these unique properties:

- Its modulus of elasticity is much higher than any other common material.
- It's extremely light (density Be 1.845, Al 2.699 g/cc).
- Its strength-to-weight ratio is higher than other materials, including titanium alloys.
- It has a high melting point, keeping its usable strength at elevated temperatures.

Industry says it's ready to use beryllium whenever it is available in a variety of shapes and sizes. While beryllium plants are now producing at far below capacity, a boom within the next five years has been predicted. Although nearly all shapes are now being produced from powder, recent reports indicate that cast and wrought shapes soon will be available.

WHY POWDER METALLURGY?

The original need for beryllium in atomic energy work was so urgent there was no time for extensive research. Powder metallurgy could, and did, deliver the required parts. In fact, the limited early development work indicated that it couldn't be fabricated by any other process because of its ductility, grain size, castability, and workability.

While the greatest demand for fabricated beryllium is still from the Atomic Energy Commission, guidance and space programs are demanding more fabricated parts. To satisfy these demands, conventional methods of fabricating beryllium must be developed, such as casting, forging, rolling, and extruding.

Meanwhile, the demand for fabricated parts does exist. Since the only way to make them commercially at present is by powder metallurgy, let's review the current technology of the powder. (Note: Since this paper was written, Wyman-Gordon has announced the successful closed-die forging of beryllium.)

Table I gives the properties of beryllium which are most important in powder metallurgy. Its high sintering temperature and relatively low recrystallization temperature combine to make the production of fine-grain-sized compacts impossible.

The microstructure of pressed and sintered beryllium shows an exceptionally large amount of twinning and slip bands. The notorious brittleness of the metal is a natural result of the hexagonal close-packed structure and low c/a ratio. The great amount of twinning and slipping that results from deformation also produces high strength. Beryllium can be successfully vacuum sintered, as you'd expect from its vapor pressure.

Beryllium can be cold pressed to give compacts that can be handled. At 75 tsi forming pressure, the green compacts have a density of 85% of theoretical. Sintering in an inert atmosphere gives compacts with densities of 90-95% of theoretical. Sintering in a vacuum gives even higher densities. Sintered compacts made by cold pressing and sintering in either an inert atmosphere or in a vacuum are coarse-grained and brittle.

Figure 1 shows two ductility peaks, one at about 800° F and the other at about 1400° F. By pressing at either temperature, you can make denser compacts with far less cold working. Warm-pressed parts can be made to close tolerances because the dies usually are of metal and accurately machined.

Beryllium fabrication processes are summarized in Table II. While considerable progress was made during the late 1940s on fabrication by cold press and sintering, most work today is by hot pressing methods. One reason for getting away from cold press and sintering is that industry needs parts that are much larger than presses can make, except by hot pressing. Furthermore, production runs are usually so small that the cost of tooling for cold pressing can't be justified.

Hot pressing, which gives higher densities and finer grain structures, is the start for most extruded and rolled shapes. Pressing is above the recrystallization temperature, but still low enough so there is little grain growth. Since beryllium is relatively weak

TABLE I

Physical Properties of Beryllium

Melting Point	2345°F
No. of Phases	1
Recrystallization Temperature	1450°F
Structure	hexagonal close packed c/a 1.56
Deformation Mechanisms	Twinning and Slipping
Vapor Pressure	600 microns at 2200°F
Sintering Temperature	2000-2300°F

TABLE II

Powder Metallurgical Processes for Forming Beryllium

1. Hot Pressing
2. Warm Pressing
3. Cold Press and Sinter
   a. Sintering of loose powder
4. Pressing and Extrusion (or rolling or forging)
   a. Press Forging

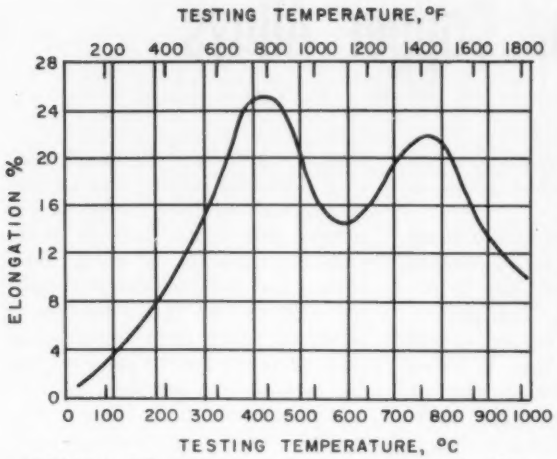


FIGURE 1. Effect of temperature on beryllium's ductility.

at hot-pressing temperatures, only light forming pressures are needed.

During hot pressing, there is very little slippage or fracturing of the metal particles. The particles do, however, distort enough to almost entirely fill interparticle voids. Dies for hot pressing are inexpensive, being generally made of either graphite or low-carbon steel. Since only a few hundred psi pressure is required, large pressings up to 3′ x 6′ can be made.

The properties of beryllium fabricated by various methods are summarized in Table III. Strengths between 40,000 and 100,000 psi can be attained. Ductilities vary from zero to 20%. Generally speaking, beryllium's lack of ductility is its greatest drawback. A complicating factor is that ductility depends on the direction in which the sample is cut, either with or across the direction of working.

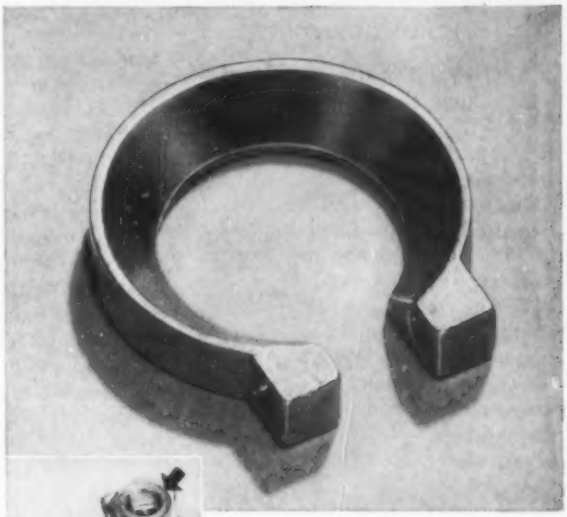
Billets made by hot pressing may be machined into shapes; they may be extruded into bars, rods, and tubes; they may be rolled into sheet or strip; or they may be forged.

TABLE III

Physical Properties of Beryllium

	UTS. ($X10^3$, psi)	YS. ($X10^3$, psi)	%El. (in 1")
Hot Pressed	35-45	25-40	0.3-3
Warm Pressed	110-120	—	—
Hot Extruded	60-95	40-55	7-20
Warm Extruded and Annealed	65-90	45-55	2-7
Warm Extruded	85-100	80-90	0-1.5
Hot Rolled Sheet	60-95	45-75	3-10

ADVANTAGES SUCH AS THESE with ***METAL POWDERS***



provide parts that serve dual purposes

This NICKEL SILVER metal powder part does two jobs: (1) locks the end cylinder and (2) provides vertical tension for the SIGMA Series 72 Polar Relay. These complicated devices must be accurate, compact and dependable for instrumentation, computers, telegraphy, controls, and alarm systems.

Making this part by any method, other than powder metallurgy, would be difficult and expensive. Giving the job to a custom fabricator*, SIGMA INSTRUMENTS found that design and strength requirements of this critical part could be provided at a reasonable cost—uniformly accurate and ready for assembly.

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D-C Casting of Copper and Copper Alloys

by H. HENRY SINASON*

ABOUT 90% of the extrusion billets, rolling slabs and wire bars used by the aluminum industry are cast by direct chill (D-C) continuous or semi-continuous casting. About 10% of the billets, slabs and bars used by the red metal industry in the United States are cast in some type of shell mold.

Yet the advantages of direct chill, continuous casting seem so obvious that it's surprising it isn't used more by the red metals industry. The reasons most commonly given for the slowness of American industry to use the D-C casting system is lack of inexpensive casting equipment and the lack of technical knowledge.

Almost all the leading European manufacturers of copper and copper base products have been using D-C casting methods since about 1932 when it was developed by Junghans in Germany. These European firms have achieved a highly competitive position in world markets. Obviously there is plenty of technique available. Furthermore, there are today, simple, efficient, and inexpensive semi- and fully-continuous casting machines available to even the smallest independent producer.

These machines are hydraulically operated and mechanically simple. They need little space, can be run by a single operator. Their production capacity is far beyond that of any shell mold system. Casting multiple strands (either continuously or semi-continuously up to 25 ft. long) the metal gate loss is less than 1%. The casting is of the highest metallurgical quality. Surface finish is incomparably superior to the best obtainable with a shell mold.

The most critical part of a continuous casting system is the mold itself. There are new mold designs, new mold materials, revised theories of heat exchange between mold interface and cooling water. These things enable us to increase speeds, maintain high surface and structural qualities.

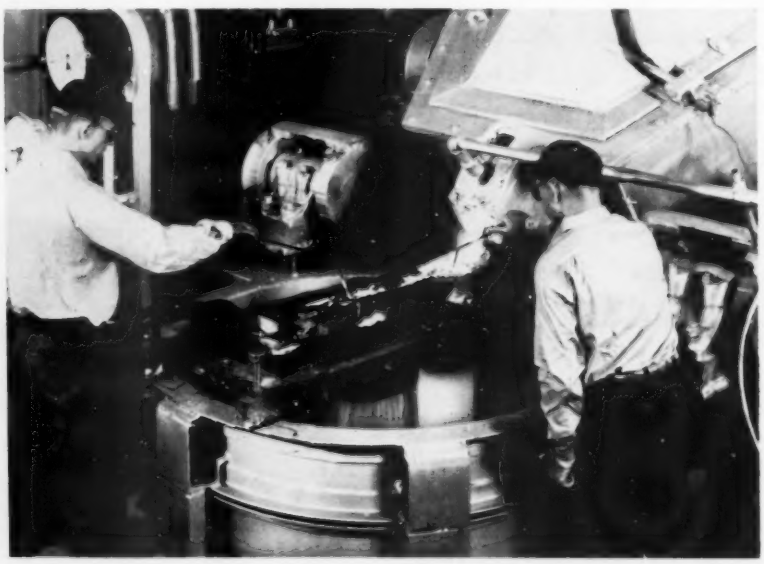
The heavy coating of zinc oxide on the surface of copper-zinc alloys has been a problem. It's caused by the evaporation of metallic zinc during pouring. Subsequently, the zinc vapor condenses as oxide at the mold interface. This oxide layer becomes so heavy that it impedes the flow of metal from the mold. Finally it tears from the mold, marring the mold surface and leaving the surface of the casting so encrusted that it may have to be rejected. Oxidation is even more severe and troublesome if the alloy contains lead. It may be carried along in vapor form by the zinc and redeposited in the same way on the mold casting interface.

To avoid the zinc oxide troubles, modern D-C casting machines have oscillating molds. This prevents the zinc oxide from building up. The oxide is deposited as a fine film, evenly over the casting surface. It gives the casting a smooth, uniform appearance. The improved casting surface eliminates rejects due to bad surfaces and damage to the mold due to tearing is absent.

Metals and alloys subject to gaseous contamination have been troublesome. New mold materials have nearly ended this difficulty. The organic lubricants formerly used are not needed so that one source of gaseous contamination is removed. In addition to being self lubricating, new molds allow the use of metallic or chemical additives to provide a protective atmosphere in the mold. The result: the

continued on page 84

*TECHNICAL MANAGER
LOBECK CASTING PROCESSES, INC.



D-C CASTING MACHINE (right) is easy to operate for high-volume runs of brass rolling mill slabs (above).

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Investment Casting Institute Standards

Part 1: Purpose, Surface Quality, X-Ray

PURPOSE

IN CASTING INSPECTION, those procedures involving X-ray, Zyglo, Magnaflux and visual have consistently presented the greatest problems for both the foundry and the customer. These various inspections have rarely contained definite and measurable limits of acceptance and rejection, but rather have been forced to function by the inaccuracies of interpretation by individual inspectors.

Lack of a means of positive measurement has caused misunderstandings between customer and vendor, and in many cases, the rejection of acceptable castings. In addition, vague inspection specifications make difficult the foundries' task of accurately pricing new parts, and can result in unnecessary cost to the customer.

A similar, but no less troublesome, problem lies in the definition and measurement of surface finish. Existing methods of surface inspection are suitable only on a percentage basis and most companies must depend on inspection personnel with an educated finger to determine whether a casting is acceptable or rejectable.

It is the purpose of this manual to eliminate, as much as possible, the intangible areas of these inspections. In the sections covering Zyglo, Magnaflux, X-ray and visual, the specifications are separated into classes, with a breakdown of imperfections that are acceptable within the scope of these classes. It is suggested that the designer review a particular casting to determine what areas would require a Class I quality level and apply a lower class to non-critical areas.

Customers should recognize that the application of the more relaxed standards, where practical, will result in a less expensive part, and will allow the foundry to concentrate on the more critical areas and improve the quality of the part. In addition, the customer should furnish a drawing of the part indicating the areas where the various class standards will be effective. These areas should be defined by dimensional limits to eliminate borderline areas of interpretation.

These standards are presented as a guide to potential users, and it is recognized that special cases will require more stringent standards than are set forth here.

SURFACE QUALITY

General

One of the recognized advantages of the use of investment castings is the broad selection of surface finishes available. Current manufacturing techniques provide finishes ranging from 125 RMS in the as-cast condition to 32 RMS for processed surfaces. Better surface finishes may be provided by special processing or supplementary mechanical operations. Such processing, however, is directly reflected in the cost of a part.

The designer should correlate the actual finish requirements of the casting with the cost factors involved, by specifying only those areas where particular finishes are needed. Wherever possible, a drawing of the casting should be made, clearly indicating those special areas.

To provide a uniform method of interpretation of surface quality, numerical standards have been established which express in microinches the average amount by which the finish may vary from the nominal surface.

The required surface quality is indicated by the use of the symbol ✓ enclosing the desired microinch value. A series of values in terms of surface finishes usually encountered in castings includes the following: 32, 63, 90, 125, 250.

Surface quality standards are applicable under the following conditions:

1. The general surface quality value is specified in the general drawing notes. Other surface quality values are indicated by the symbol on the appropriate surface.
2. The whole area of a continuous surface shall meet the requirements of the value applied to that surface, except that, unless otherwise noted, minor imperfections, such as pits or positive metal, not to exceed 10% of the referenced surface are permitted, providing they are accept-

NOTE: These standards are taken from the Investment Casting Institute's standards manual. Because of space limitations, they will be published in three parts: Part I, covering Purpose, Surface Quality, and X-ray; Part II, next month, will cover Visual Standard and Penetrant and Magnetic Particle Inspection; Part III, the following month, will cover Airfoil standards.

able under visual acceptance standards.

3. Any process may be used to obtain the specified surface quality, as long as the resulting surface conforms to dimensional and surface quality requirements. The applied symbol does not indicate that machining is required.
4. All metal castings may be evenly blasted with sand, grit, or vapor.
5. Areas of transition, such as chamfers, fillets, beads, countersinks, etc., shall conform to the roughest adjacent area unless otherwise specified.
6. Tolerances will not be applicable to the specified surface quality values. The surface quality specified shall be considered to mean the maximum acceptable value. A smoother surface than that specified shall be acceptable.
7. Where width, waviness, or lay is specified, the symbols used shall be in accordance with Military Standard MIL-STD-10.
8. Evaluation of surface quality shall be made visually by use of a cast visual surface finish comparator designed to evaluate the finishes of cast surfaces.
9. This comparator is to be used as a visual gauge in the design, production and inspection of castings. Standardization of the comparator may be accomplished by profilometer or surface analyzer measurement.
10. Unless otherwise specified, the effect of flaws shall not be included in roughness evaluation. Flaws are irregularities that occur at one place or at relatively infrequent intervals. Flaws include defects as cracks, holes and scratches, etc.

X-RAY STANDARDS

General:

1. Terminology for this inspection shall apply to sub-surface imperfections only. Surface imperfections shall be covered by Zyglo and visual standards.
2. Propagating Imperfections: Cracks, hot tears, dendritic shrinkage, cold shuts, oxide folds, non-propagating imperfections aligned as to indicate possible stress concentration.
3. Non-propagating Imperfections: Blow holes, pin hole porosity, globular gas porosity, globular shrinkage cavities, inclusions.
4. Non-propagating Dispersed Imperfection: Gas porosity, shrinkage porosity, microshrinkage, segregation, mottling, etc.
5. Intergranular Shrinkage: Commonly called "grain" in aluminum castings.

It should be noted that wherever possible it is desirable for customer and foundry to work from standard X-ray films established for particular parts rather than a written standard.

Matters of X-ray techniques, exposures, etc., are not part of this manual and should be established directly between the customer and vendor.

For reasons of economy, the designer should specify different class standards for various areas of a casting. If this is the case, a drawing of the part should be made, which clearly defines the areas and specifies the classes applicable to them.

In establishing standards on both X-ray and Zyglo it should be noted that linear imperfections running parallel to the lines of stress are less critical than those lying perpendicular to the plane of the stresses. Allowance should be made in the allowable indication for such a situation.

From the standpoint of economy, wherever possible, the customer should allow repair welding to correct X-ray and visual defects.

NEXT MONTH: Part II, Visual Standard and Penetrant and Magnetic Particle Inspection.

DESCRIPTION	CLASS I	CLASS II	CLASS III
Propagating Imperfections	Unacceptable	Unacceptable	Acceptable up to 5/16" in length.
Non-propagating Imperfections	1/32" in diameter; 4 indications per square inch.	3/32" in diameter; 6 indications per square inch.	Acceptable
Non-propagating dispersed Imperfections	No closer than 1/4" apart. Acceptable	No closer than 1/8" apart. Acceptable	Acceptable
Inter-granular Shrinkage (Aluminum only)	Degree of acceptable imperfections in this classification can best be established by actual X-ray film standards furnished by the customer.		

Note: Volume of imperfections, in all classes, not to exceed 5% of volume of area in which they are located. Diameter of imperfection shall not exceed 20% of smallest cross section in which the imperfection is located.

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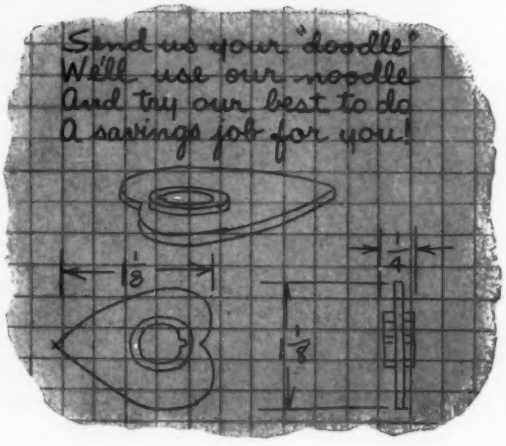

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CUPRIC OXIDE • CUPROUS SULFIDE • CUBOND COPPER BRAZING PASTE • COPPER PIGMENT

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PROPERTIES OF EXTRUDED ALLOYS—TABLE X

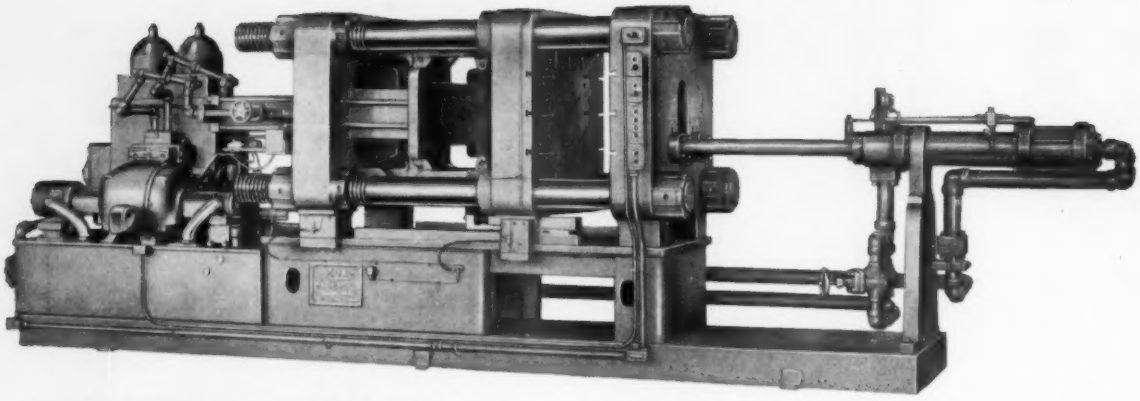
Chemical and Mechanical Properties of Magnesium Extrusion Alloys

ASTM alloy	Nominal composition, %					Condition[1]	Diam of thickness in least dimension, in.	TS, 1,000 psi		TYS, 1,000 psi		Elongation, % in 2 in.		CYS, 1,000 psi		Bearing strength, 1,000 psi				Shear 1,000 psi		Hardness	
																Ultimate		Yield					
	Al	Mn	Zn	Zr	Mg			Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Typ.	Min.	Brinell	Rockwell E
AZ31B	3	0.45	1	—	Balance	—F	Under 0.250	38	35	29	21	14	10	15	—	56	45	33	23	19	17		
						—F	0.250-1.499	38	35	29	22	15	10	14	12	56	45	33	23	19	17	49	57
						—F	1.500-2.499	38	34	28	22	14	10	14	12	56	45	33	23	19	17		
						—F	2.500-5.000	38	32	28	20	15	7	14	10	56	45	33	23				
AZ61A	6.5	0.30	1	—	Balance	—F	Under 0.250	46	38	33	20	17	8	—	—	65	53	38	30				
						—F	0.250-1.499	45	40	33	24	16	10	19	14	68	55	41	32	20	18	60	72
						—F	1.500-2.499	45	40	33	24	16	10	19	14	68	55	41	32	20	18	60	72
						—F	2.500-5.000	45	40	31	22	15	7	21	14	68	55						
AZ80A	8.5	0.25	0.5	—	Balance	—F	Under 0.250	49	43	36	28	12	9	—	—	68	56	48	40	22	19	60	77
						—F	0.250-1.499	49	43	36	28	11	9	—	41	68	56	48	40	22	19	60	77
						—F	1.500-2.499	49	43	35	28	11	8	—	17	68	56	48	40	22	19	60	77
						—F	2.500-5.000	48	42	36	27	9	4	—	17	68	56	48	40	—	—	60	77
						—T5	Under 0.250	55	47	38	30	8	5	34	—	—	—	—	—	—	—	82	88
						—T5	0.250-1.499	55	48	40	33	7	4	35	28	—	—	—	—	24	21	82	88
						—T5	1.500-2.499	53	48	39	33	6	4	32	27	—	—	—	—	24	21	82	88
						—T5	2.500-5.000	50	45	38	30	6	2	31	26	—	—	—	—	—	—	82	88
M1A	—	1.5	—	—	Balance	—F	Under 0.250	37	0[illegible]	26	—	12	2	12	—	51	45	28	23	—	—	44	45
						—F	0.250-1.499	37	32	26	—	11	3	12	—	51	45	28	23	18	15	44	45
						—F	1.500-2.499	39	32	—	—	9	2	—	—	51	45	28	23	18	15	44	45
						—F	2.500-5.000	38	29	—	—	5	2	—	—	51	45	28	23	—	—	44	45
ZK60A	—	—	5.7	0.55	Balance		Cross-Sect. area, sq. in.																
						—F	Less than 2	49	43	38	31	14	5	33	27	80	70	55	45	27	22	75	84
						—F	2-3	49	43	37	31	14	5	28	26	80	70	55	45	27	22	75	84
						—F	3-5	49	43	36	31	14	5	27	25	80	70	55	45	27	22	75	84
						—F	5-40	48	43	37	31	9	4	23	20	80	70	55	45	27	22	75	84
						—T5	Less than 2	53	45	44	36	11	4	36	30	85	71	59	47	26	22	82	88
						—T5	2-3	52	45	43	36	12	4	31	28	85	71	59	47	26	22	82	88
						—T5	3-5	51	45	42	36	14	4	30	25	85	71	59	47	24	21	82	88

[1] —F = as extruded; —T5 = artificially aged

PEMCO* die castings cut the world's lawns...and

KUX cuts Pemco's costs



THE MAMMOTH KUX HP-38

Hydraulically operated cold chamber model for the production of die castings from aluminum, brass or magnesium.

Also available in plunger gooseneck model for the production of die castings from lead, tin or zinc

Model BH-38

KUX
MACHINE COMPANY
6725 North Ridge Avenue, Chicago 26, Ill.

Builders of a full range of die casting machines... from 25 tons to 1000 tons in size.

*PEMCO, trade name of PRODUCT ENGINEERING AND MANUFACTURING CORPORATION, Bridgman, Michigan, uses many sizes of KUX Die Casting Machines to produce top quality die castings for industry.

The rotary lawn mower housing illustrated is an example of the high quality large die castings made by Pemco for leading producers of lawn mowers and other major household appliances. To make them with speed and cost-cutting efficiency, Pemco relies on the mammoth Kux HP-38, with its exceptional capacity for large dies, coupled with ease of mounting, tremendous metal injection pressures and plunger speed.

This one piece aluminum die casting measures 24" x 24" and weighs 15 lbs. Produced at an average speed of 60 castings per hour, with the aluminum injected into the die at a pressure of more than 5000 lbs. PSI, a die locking pressure of 750 tons is required. Thus the HP-38, having this capacity, has proven to be the ideal machine to accomplish this die casting job.

If you have a casting problem of unusual size or intricacy, come to Kux, where no die casting problem is too big or too small for our experienced engineers to solve to your advantage.

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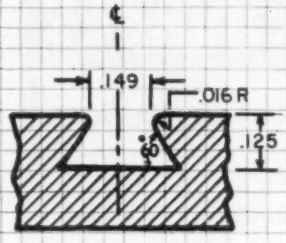
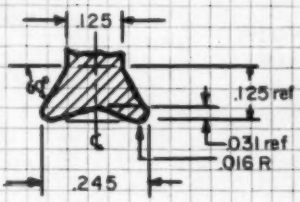
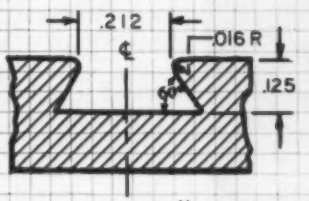
use these PMM **Design Tips** for lower costs -better products

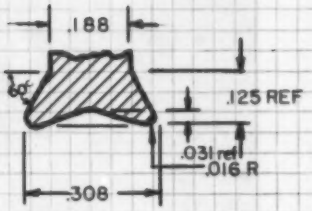
STANDARD DOVETAILS: *Illustrated below are the standard dovetails. A standard dovetail note will be placed as near as practical to the dovetail outline with a leader extending from the note to the dovetail. This note may be used in place of dimensional detail.*





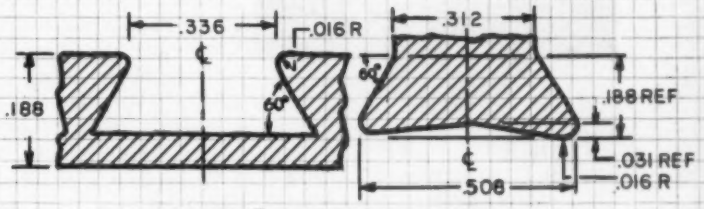
Std 1/8" — 30° Dovetail





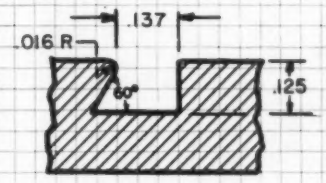
Std 3/16" — 30° Dovetail

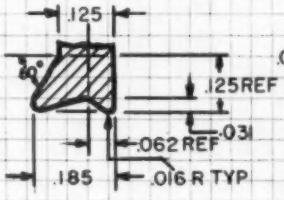
Notes to be used:
STD 1/8" — 30° DOVETAIL
STD 3/16" — 30° DOVETAIL
STD 5/16" — 30° DOVETAIL



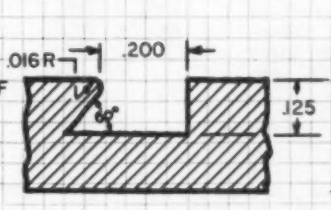
Std 5/16" — 30° Dovetail

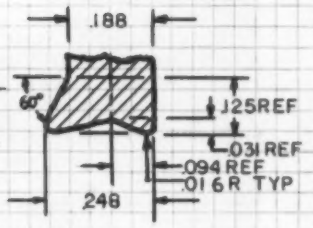
STANDARD HALF DOVETAILS: *Illustrated below are Standard Half Dovetails. A standard half dovetail note will be placed as near as practical to the dovetail outline, with a leader extending from the note to the dovetail. This note may be used in place of dimensional detail.*





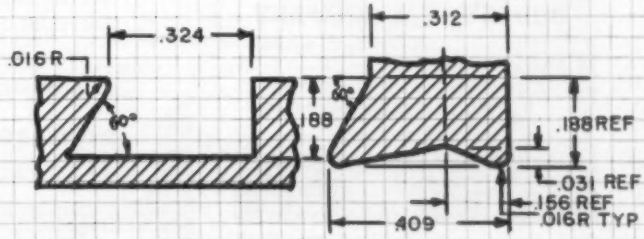
Std 1/8" — 30° ½ Dovetail





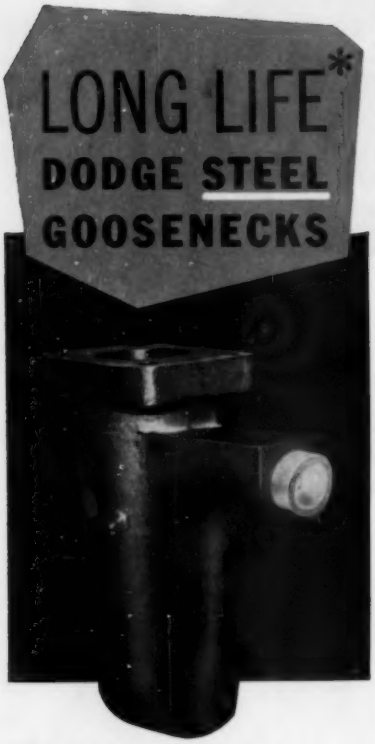
Std 3/16" — 30° ½ Dovetail

Notes to be used:
STD 1/8" — 30° ½ DOVETAIL
STD 3/16" — 30° ½ DOVETAIL
STD 5/16" — 30° ½ DOVETAIL



Std 5/16" — 30° ½ Dovetail

Reprinted by courtesy of: The Aluminum Extruded Products Division of The Aluminum Association



DESIGN
- MINIMUM weight to save you money
- MAXIMUM strength for higher pressures

MATERIAL
- Special composition alloy steel
- Highly resistant to zinc
- No washout in neck . . . no bottom breakout . . . no spout erosion

MANUFACTURE
- Sound castings—produced through 40 years' experience in the manufacture of steel castings for pressure applications

* Users report better than 4 year service life!

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DODGE STEEL COMPANY

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THE MOST IMPORTANT ALLOY IN A STEEL CASTING IS QUALITY

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MPI ELECTS OFFICERS

George A. Roberts, vice president-technology at Vanadium-Alloys Steel Co., was re-elected president of the METAL POWDER INDUSTRIES FEDERATION at the 15th annual meeting held recently in Detroit. The MPI board of governors also re-appointed Kempton H. Roll as executive secretary and treasurer.

DOW REORGANIZES MAGNESIUM SALES

THE DOW CHEMICAL CO. has divided its magnesium sales organization into two separate groups: Metal Sales Dept., which will specialize in primary metal, alloy ingot, and cast anodes, and Magnesium Products Sales Dept., which will concentrate on sheet, extrusions, sand and die castings, and fabricated products.

William S. Loose, formerly sales manager for all magnesium products, will be manager of the Metal Sales Dept. Donald H. Gilmore, formerly manager of Dow's Pittsburgh sales office, will head the Magnesium Products Sales Dept.

Circle No. 67 on the Reader Service Card

PLYMOUTH BRAND

METALLIC
STEARATES

LITHIUM STEARATE

Have You Tried LITHIUM STEARATE As A Lubricant?

Write for samples and data.

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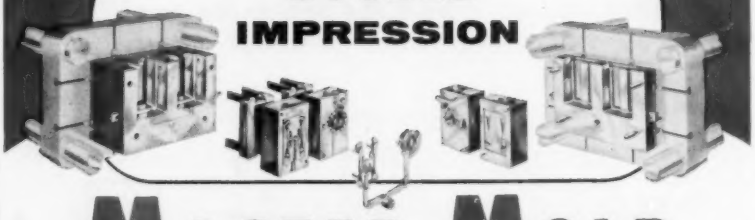
shoot in the lower position! mold vertically!

RICHARDS

DOUBLE IMPRESSION



MASTER-MOLD

for aluminum and zinc die casting

It's here now — vertical position, double-impression molding. With Richards Master-Mold, either or both molds can be changed *in minutes,* from the top, with eye bolts and regular hoisting equipment. Eliminates manual handling of hot molds, saves time — speeds production.

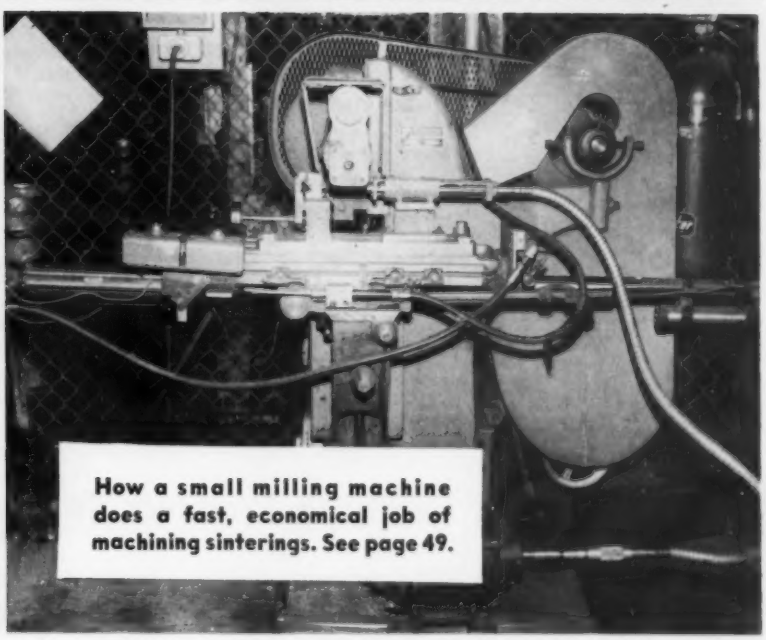
Write for full particulars and prices on Richards Vertical Position Master-Molds and cavity blocks.

RICHARDS TOOL AND MOLD COMPANY
2715 LATHROP AVENUE • RACINE, WISCONSIN
107

For more information circle No. 70 on the Reader Service Card

PMM Finishing Section

The specialized finishing methods, equipment and materials used to machine, assemble, surface condition or surface coat precision metal molded parts are presented here. This includes all secondary operations which convert a raw casting to a finished product.



How a small milling machine does a fast, economical job of machining sinterings. See page 49.

Now-28 ISOBRITE® PLATING BRIGHTENERS

For Zinc, Cadmium, Copper and White Brass

HAVE THE *FOUR* BIG FEATURES YOU ASKED FOR!

When the Allied line of brighteners, now known as ISOBRITE, had the famous ARP trademark on them, we made a survey to find out exactly what *you* wanted most in brighteners. Your answers helped guide our research and development staff in evaluating and consolidating our new line.

Now, here are the results—the industry's most complete line—28 *ISOBRITE Brighteners with these most-wanted features:*

1. LONGER LIFE

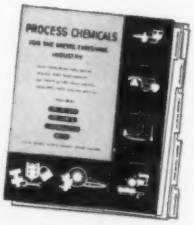
Your own records will show ISOBRITE Brighteners give longest possible life in rack or barrel plating operations.

2. BRIGHTNESS

You'll see for yourself that ISOBRITE Brighteners give a diamond-like sparkle that just can't be matched.

3. THROWING POWER

Even if your product has deep recesses, you'll get a uniform, all-over brightness that only ISOBRITE Brighteners can give you.



4. WIDER BRIGHT RANGE

ISOBRITE Brighteners operate efficiently over exceptionally wide current density ranges and have greater tolerance for temperature change.

Remember, there's an ISOBRITE Brightener especially designed for your specific operations—whether you're rack or barrel plating zinc, cadmium, copper or white brass . . . an ISOBRITE Brightener that is entirely compatible with most other brighteners. Don't just order brighteners—specify ISOBRITE. There *is* a difference!

Your Allied Finishing Systems Engineer will be glad to discuss the benefits of ISOBRITE Brighteners in your operations. He's listed in your 'phone book under "Plating Supplies." Or, write for technical data and product list giving details of your operations.

Allied Research Products, Inc. 4004-06 EAST MONUMENT ST., BALTIMORE 5, MD.
Branch Plant: 400 Midland Avenue, Detroit 3, Michigan
West Coast Licensee for Process Chemicals: L. H. Butcher Co.

Chemical and Electrochemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing

IRIDITE® Chromate Coatings | IRILAC™ Clear Coatings | ISOBRITE® Brighteners | ARP® Plating Chemicals | WAGNER Equipment

For more information circle No. 79 on the Reader Service Card

Small, versatile milling machine gives . . .

Fast, Economical Machining of Sinterings

SMALL MILLING MACHINES have proved to be the efficient answer for increased flexibility in the production operations of Ferro Powdered Metals. Ferro manufactures a multitude of odd shaped pieces in production quantities. The pieces need a lot of slotting and drilling operations that cannot be done efficiently in the powdered metal presses.

To do these production slotting, drilling operations, Ferro uses No. 1 U. S. Milling Machines. According to J. F. Helsel, president, these small mills are ideal for Ferro's type of work, since they are simple and inexpensive, yet permit rapid setup changes and are highly productive.

A typical application is the production of governor thrust forks. This part combines a highly precision pressed part with an economical milling and drilling operation to get a substantial reduction in cost. Two vital fork structural areas are first formed in the pressing and sintering operation.

The .375/.377 diameter hole is press formed. This eliminates a drilling operation. Also, the finished cam surface of the fork is made in the die to form the odd shape without intricate, costly cam turning operations.

TWO OPERATIONS IN ONE

However, the .570/.590 slot cannot be formed in the pressing die. By using a No. 1 U. S. Mill, Ferro can mill the slot efficiently, and also drill the No. 3 hole. The two machine operations are done in one pass by incorporating a multi-angle drill unit in the milling cycle.

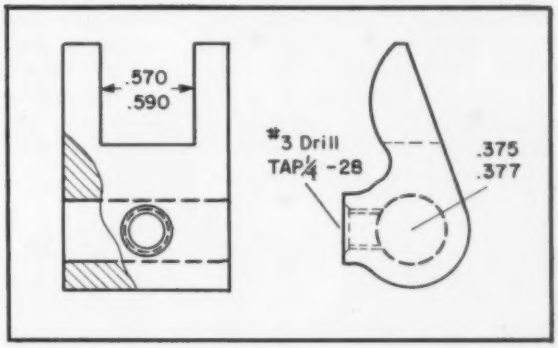
The operator places the part in a special fixture, which assures accurate location, and locks it in place. He pushes the "start" button and the air hydraulic table feeds, then returns. The milling and drilling taking place at the same time. The finished fork is then replaced with a new part, and the cycle repeated.

Not only is a costly handling step eliminated, but considerable production time is saved by performing both operations at the same time. Production rate is 160 parts per hour at 100% efficiency. The subsequent operations needed to complete this part are the ¼-28 tapping, carbonitriding, and barrel burnishing. The material used for the governor thrust fork is sintered iron-copper, pressed to a 6.3/6.8 g/cc density.

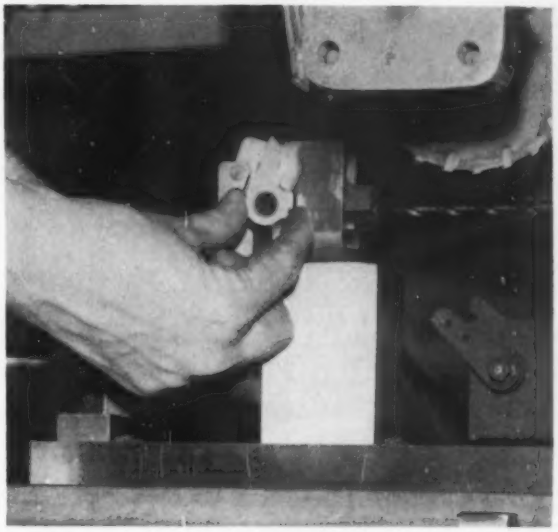
Simple construction of the milling machine has facilitated set-up for the variety of functions demanded by Ferro's versatile production of sintered metal powder parts. Low cost operation is also available for keyways, sawing, slotting, squaring, cut-off, short-run splining and light slab milling; all of these operations are sometimes demanded.

In many cases the use of these small, highly versatile milling machines has allowed a big reduction in tooling costs. They also speed up production because the simplified tooling can run at higher speeds.

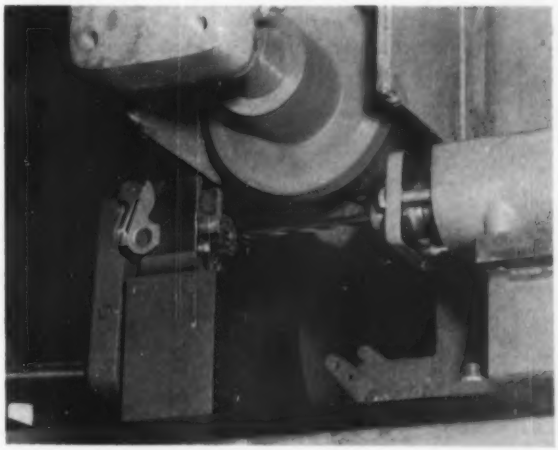
HERE'S THE PART . . .



IT'S PLACED INTO A FIXTURE . . .



AND MILLED, DRILLED, IN ONE PASS.



A new integrated process for . . .

Continuous Cleaning and Painting

INDUSTRIAL FINISHING of metal is a huge enterprise. It is estimated that over 150 million gallons of paint, worth more than $500 million are used annually for painting of new work. Systems in use vary widely, but a large portion of all work finished is still done by hand-spray methods. These waste approximately 50% of the paint and require excessive operating labor. Several improved painting methods such as dipping, flow-coating, and electrostatic spraying have been finding increasing use. Such methods are less wasteful of paint, but often suffer from other major disadvantages. These are high investment cost, high space requirements, and serious fire and explosion hazards. In all instances, the valuable paint thinners are lost during drying and curing.

Here is a new approach to finishing of metal.* It combines metal cleaning with application of a coating of paint in a single conveyorized unit. The unit employs recently-developed paints which contain non-flammable thinners. When the new technique is used, overspray loss is eliminated, thinner is recovered, labor requirements are minimal, major savings in floor space and utilities are attainable, and fire hazards are eliminated.

Material for this report supplied by E. I. Du Pont De Nemours & Co. (Inc.) Electro Chemicals Department; Chlorine Products Division, Wilmington 98, Del.

THE PROCESS

Present metal finishing practices require a series of steps which tie up large manufacturing areas, and are often wasteful of materials and labor. For example, a common sequence includes cleaning of the part either by vapor degreasing or by wet cleaning methods, then oven-drying. Paint is then applied, with poor efficiency and at high labor cost, by hand spraying, or is often applied by dipping or flow-coating. It must then drain for several minutes, creating an untidy drip area which is a potential breeding spot for a disastrous fire. During conventional flow-coating, extreme care must be used to avoid formation of explosive vapor zones. In most cases, the newly-painted work is heated to drive off volatile thinners. Even if the paint is a non-curing type, it is heat-dried to avoid holding large inventories of wet parts. Many of these undesirable and costly features of conventional finishing systems can now be eliminated.

A new type paint using trichlorethylene thinner makes possible direct integration of cleaning and painting within a single machine, which is divided into two zones. The zones are connected, and both are covered with a continuous blanket of trichlorethylene vapor, as shown in Figure 1. Work is cleaned in the first zone; paint application and leveling of the paint film occur in the final zone. These features permit the manufacturer to add a dirty part to the conveyor at the inlet of the machine, and to remove the part at the discharge end, clean, painted, dry, and ready to ship.

THE ECONOMICS

Investment. A single, compact system has been substituted for a multiplicity of separate cleaning, painting and drying units. No drainboard areas are needed. Space

continued on page 52

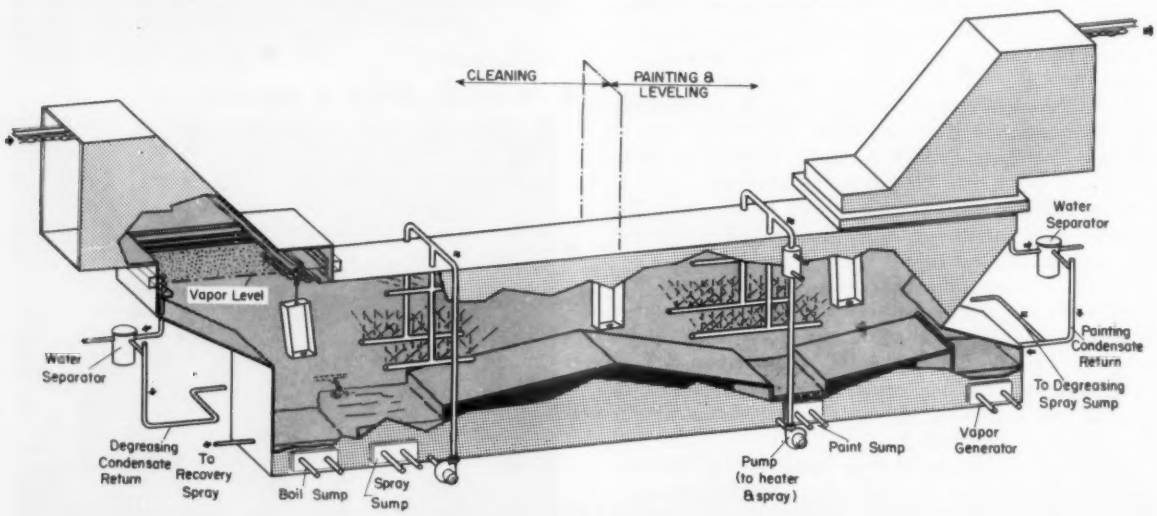


FIGURE 1. Combined vapor degreasing and painting unit.

"Enthol 230 solution completely removed buffing compound in 5 minutes!"

At Regal Plating Company, Providence, R. I., these brass keys have just been soaked for 5 minutes in a 3.5% by volume solution of Enthol 230 at 180° F. Buffing compound packed in design work and crevices has been effectively dissolved away.

Regal joins a growing list of platers who have discovered the efficiency of new Enthol 230 in cleaning out the deep crevices, engravings, and filigree work in ornate costume jewelry. As for economy, Regal reports that an 85-gallon tank of cleaning solution required only 3 gallons of Enthol 230 for make-up and 1 gallon for replenishment over a 6 week period! The "ammonia wash" used previously, could not compete with this low operating cost.

Whatever your buffing compound removal problem, this new, mildly alkaline, liquid detergent should solve it. Enthol 230 solutions penetrate and dissolve even hardened buffing compounds, and, in many instances, have eliminated hand brushing of parts. The solutions have extremely long life and high tolerance to contamination by dissolved soils. Enthol 230 solutions can clean steel, zinc die castings, aluminum, copper, brass, white metal, lead, nickel plate, gold, and silver. They are excellent for use in ultrasonic cleaning. Write today for complete information, to Enthone, Inc., 442 Elm Street, New Haven, Conn.

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CLEANING & PAINTING

continued from page 50

requirements are sharply reduced, as are utilities needs; these improvements can be translated directly to reduced initial investment costs.

Materials. Paint consumption is limited to that applied to the parts, because there is no overspray loss. A single machine is used for both cleaning and painting operations; over-all solvent losses are essentially equal to those of an efficient vapor degreasing operation. The trichlorethylene thinner in the purchased paint is recovered for use in the degreasing step; the effective cost of the paint is therefore limited to the cost of the pigment and nonvolatile resins.

Operating Costs. Combining several manufacturing operations in one machine reduces costs for operating labor and utilities. Heat applied during cleaning is used effectively to evaporate the volatile paint thinner (trichlorethylene) before finished parts leave the machine, thus permitting recovery of thinner at no added cost. Operating and maintenance labor for a single operating unit are lower than for conventional methods where multiple units are used.

SAFETY

Trichlorethylene is rated by the Underwriters' Laboratories as nonflammable at ordinary temperatures. Thus, fire and explosion hazards are virtually eliminated and lower insurance premiums apply.

PAINTS

Paints used in this process must be made by the paint manufacturer to contain trichlorethylene as the only volatile thinner; dilution of conventional paints with trichlorethylene will not produce a material which can be used safely or efficiently in this equipment. Experiments show that a wide variety of trichlorethylene-thinned paints can be compounded to duplicate the properties of most conventional paints. For example, paint based on several types of alkyd resins can be formulated; asphaltic materials, including "Gilsonite", and some specialty resins such as certain acrylics, epoxy esters, and chlorinated rubbers can also be used in compounding trichlorethylene-thinned paints. Continued study is in progress to widen the scope of the new process, and to make available additional information concerning paint formulation. Prior to undertaking large-scale use of a particular new paint, simulated use tests are indicated to be sure the new product will be suitable for its intended use.

Where temperature-sensitive resins are used, the lower boiling (104° F.) methylene chloride may be used. Perchlorethylene (b.p. 248° F.) could also be used in the process but in most cases trichlorethylene (b.p. 188° F.) is preferred.

THE EQUIPMENT

The unit consists essentially of two sections. The first section serves to clean the incoming oily or greasy parts by use of standard degreasing techniques. The parts leave this section at the proper

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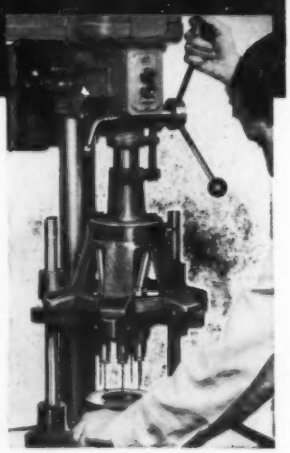

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temperature for painting, which takes place in the second section.

CLEANING

The cleaning section design depends largely upon the nature of the part, and the degree of soil. In the simplest case, the parts enter the machine, and pass into a vapor zone where pure trichlorethylene vapor condenses on the work and flushes off the contaminant. This requires only a single boiling sump with sufficient boilup to maintain the proper heat balance in the machine, similar to the well known single-stage vapor degreasing process. Cleaning by vapor exposure alone is adequate for lightly-soiled parts which have a high ratio of weight to surface.

In many cases, it is necessary to remove insoluble soils as well as soluble types. A warm, pressurized trichlorethylene spray, such as is shown in the cleaning section of Figure I, will flush off such soils. A spray system is also useful where thin sheet stock is cleaned, and the part is so light that condensation of trichlorethylene vapor does not produce enough liquid to flush off all traces of oils and greases. The choice of cleaning cycle to be used will depend upon the nature of the parts, the ratio of weight of the part to surface area, and the shape of the part. Regardless of the cycle chosen, good degreasing practice requires passing a purge stream from the boiling sump to a conventional solvent purification still, in order to remove contaminants continuously.

PAINTING

After the part is cleaned and preheated, it passes to the painting section of the machine, where boiling paint is applied by spraying or flow-coating. The temperature of the paint sump varies from 190° to 210° F., depending upon the nature and concentration of the paint. The paint is maintained at a very slow boil, which prevents either excessive solvent loss through evaporation, or thinning of the paint by condensing of solvent into cool paint. The paint to be sprayed may be passed through a high-pressure pump and preheater, so that at the spray nozzle, it is slightly above (10°-20° F.) the normal atmospheric boiling temperature. This step allows the application of paint at a higher temperature and concentration. Makeup paint is added to the chamber as necessary; overspray drains from the walls of the chamber to the sump for reuse. Since an air-free trichlorethylene vapor zone is maintained THROUGHOUT the machine at all times, the surface of the paint pool remains free of a "skin" of dried paint, and oversprayed paint is recovered for reuse.

The machine shown in Figure 1 illustrates spray or flow-coat application of paint to work which is carried by monorail conveyor. By changing the design of the machine, dip painting is also possible; where dipping is planned, use of a cross-rod conveyor will frequently prove advisable.

LEVELING & DRYING

After paint application, as the parts are advanced by the continuous movement of the conveyor, coalescing and leveling of the paint film take place rapidly. Excess paint applied during flow-coating drips off and returns to the paint sump for reuse. Essentially complete evaporation of the remaining trichlorethylene thinner in the paint coat occurs at the instant the part is raised out of the vapor. This drying is similar to the "flashing off" of trichlorethylene noted when

continued on page 77

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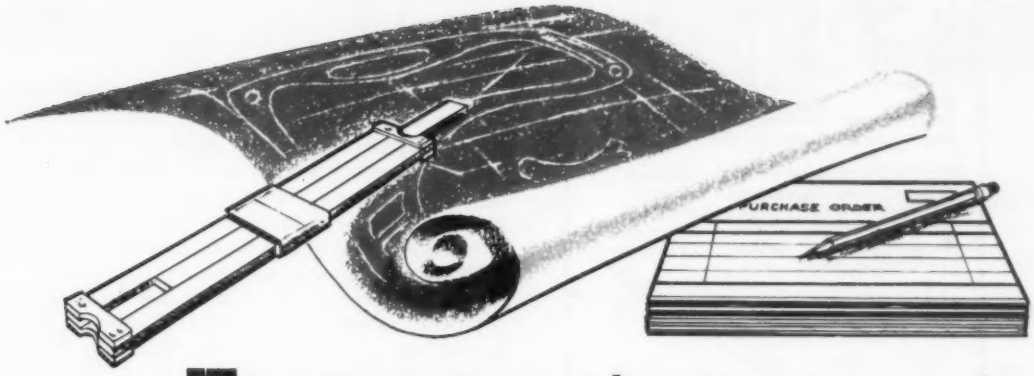


4th Annual

Investment Castings DIRECTORY

SECTION 1: REFERENCE DATA

What to consider when . . .

Designing for Load-Carrying Ability

WHAT are the most important factors to consider when designing a cast part? Most designers would agree that tensile strength of the metal comes first, followed by differing opinions on other factors.

For most cast parts, they'd be wrong.

While tensile strength – particularly as indicated by separately cast test bars – is useful as a foundry control method, it's almost useless for design. Of course, if a part functions so that any stresses are in pure tension, and if there is no variation in section thickness, then tensile strength is important. However, such a piece wouldn't be cast.

These two factors are far more significant: Shape and surface smoothness.

In the first place, a part is generally cast because its shape is too complex to be made of wrought stock, or it's too expensive to machine, or both. This means there are non-uniform sections joined together, and that any stress will be concentrated at the junction between different thicknesses.

Under this condition, the good designer throws in a fillet to help distribute the stress. But, how big should this fillet be? How effective is it?

Figure 1 shows a typical cast junction with three different fillets. With the load applied as shown, what is the effective load-carrying capacity of the cast part? Figure 1a has a 0.05" radius fillet, Figure 1b a 0.30" radius fillet, and Figure 1c a 2.0" radius fillet. With a steel casting, the load-carrying ability of the structure is increased more by an increase of fillet radius to 2.0" than it is by changing from 70,000 psi tensile strength steel to 125,000 psi tensile strength steel. Die-cast alu-

continued on next page

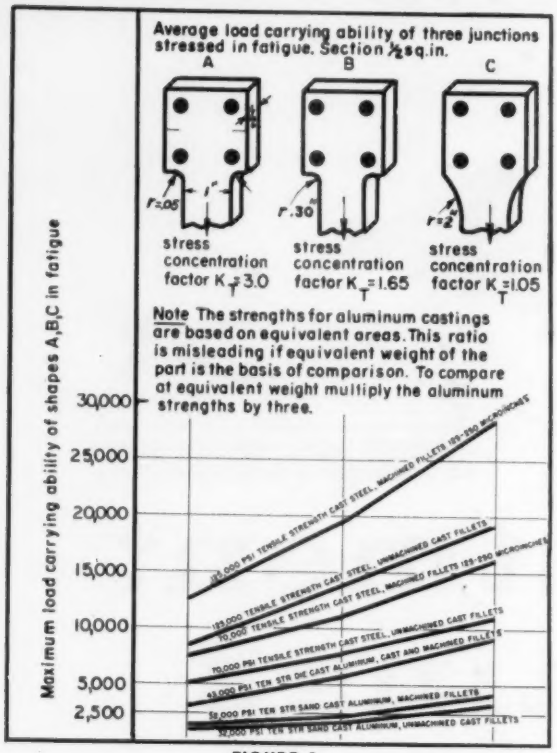

Average load carrying ability of three junctions stressed in fatigue. Section ½ sq.in.
A
B
C
r=.05
r=.30
r=2
stress concentration factor K_T=3.0
stress concentration factor K_T=1.65
stress concentration factor K_T=1.05
Note The strengths for aluminum castings are based on equivalent areas. This ratio is misleading if equivalent weight of the part is the basis of comparison. To compare at equivalent weight multiply the aluminum strengths by three.
Maximum load carrying ability of shapes A,B,C in fatigue
30,000
25,000
20,000
15,000
10,000
5,000
2,500
70,000 PSI TENSILE STRENGTH CAST STEEL, MACHINED FILLETS 125-250 MICROINCHES
70,000 PSI TENSILE STRENGTH CAST STEEL, UNMACHINED CAST FILLETS
70,000 PSI TENSILE STRENGTH CAST STEEL, MACHINED FILLETS 125-250 MICROINCHES
70,000 PSI TENSILE STRENGTH CAST STEEL, UNMACHINED CAST FILLETS
43,000 PSI TEN STR DIE CAST ALUMINUM, CAST AND MACHINED FILLETS
28,000 PSI TEN STR SAND CAST ALUMINUM, MACHINED FILLETS
28,000 PSI TEN STR SAND CAST ALUMINUM, UNMACHINED CAST FILLETS

FIGURE 1.

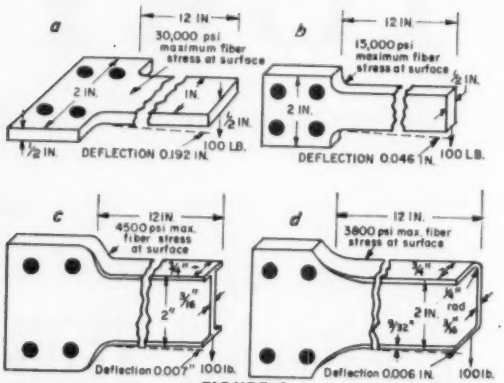


FIGURE 2.

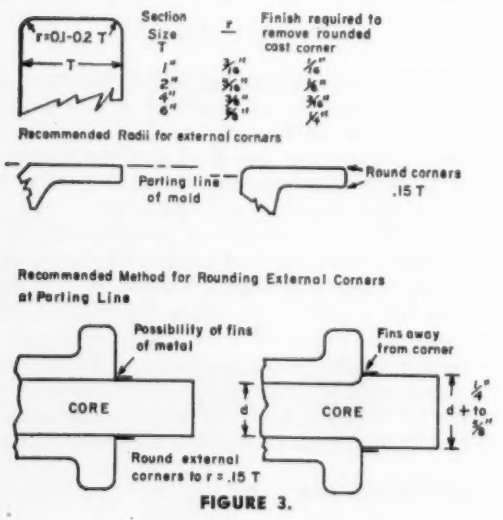


FIGURE 3.

minum and sand-cast aluminum show this same relative effect.

It's therefore safe to say that, for the average cast structure, the shape factor is more important than the tensile strength of the metal so far as service strength is concerned.

Figure 1 also illustrates the pronounced effect which surface smoothness has on the load-carrying ability of a structure. An average grade of machining (125 to 250 micro-inch finish) on the fillets has almost as great an effect on load-carrying ability as a change in the tensile strength of the metal.

So, smoothness also is more important than tensile strength in designing castings.

Now, suppose the load is simple bending instead of tension, as shown in Figure 2. The design in Figure 2a will, under a load of 100 lb, produce a fiber stress of some 30,000 psi in the outer fibers. The part thus acts like a spring. By turning the part 90° (Figure 2b), the load-carrying ability is greatly increased. While such a change is almost instinctive, what may not be known is that this simple change has greatly increased the moment of inertia.

Figure 2c shows the normal change made for wrought sections (to an I-beam), and, finally, Figure 2d shows a possible cast structure which has the strength and load-carrying ability of the I-beam, is castable, and because of its streamlined design, has the fewest possible points of stress concentration. For dynamic loading, it is far better than the I-beam.

CASTABILITY

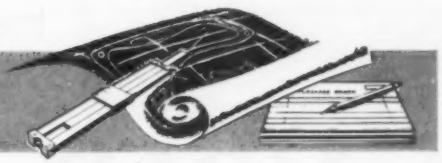
While the shape factor for maximum load carrying is of prime importance, don't lose sight of castability. Fortunately, it is extremely rare to find a case where streamlining for load carrying does not, at the same time, improve the castability of the part.

Improving design for function and castability includes such simple things as outside corners. A sharp outside corner nicks and breaks easily. This may create unexpected stress concentrations and may cause parts to be rejected because of the nicks. In the foundry, the sharp corner cools more rapidly than the rest of the casting. This difference in cooling rate increases strain concentration and may cause rupture during cooling.

Based on heat transfer data only, the recommendations for rounded corner design shown in Figure 3 will decrease the strains set up during cooling by a factor of from 2 to 5. The round corners should decrease stress concentration in service by about the same amount.

Everything that has been said about design changes to increase load-carrying ability or to improve castability comes mostly in the realm of the foundry. But, by the time a blueprint reaches the foundry, it is a finalized design. If only psychologically, changes at this stage are difficult.

Cooperation between the designer and the foundryman must start while the part is still on the drawing board, when changes are easier to make. However, the foundryman must be able to speak the designer's language. He can't be arbitrary about changes, and must have a reasonable basis for every change.



SECTION 2 ■ PRODUCT LISTING

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Investment Casting Co. (Pa.)
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Electronicast Div.
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Ferrous

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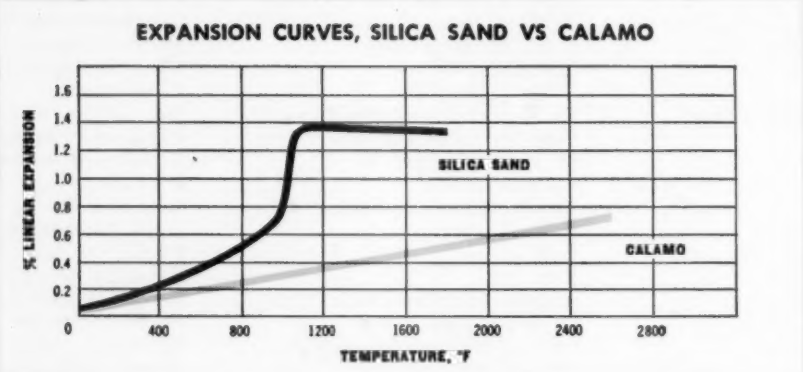
REFRACTORY MOLD MATERIALS

for metal casting



Calamo for Investment Molds

CALAMO, one of the extensively used Harbison-Walker products for molding is an alumina-silica refractory of optimum sizings for various molding mixtures. Its fusion point is 100°F. higher than that of normal silica sand mixes.

The chart above shows the exceedingly desirable expansion curve of CALAMO as compared with that of silica sand.

CALAMO, used as the major constituent of precision casting investment mixes, improves the dimensional constancy of the molds, makes them stronger and more resistant to erosion by metal flow. Investment costs are measurably reduced because an appreciably lesser amount of bonding agent is needed. This is attributable to the very desirable particle sizing and the equiaxed, dense grains of CALAMO.

CALAMO, used alone or as the major part of conventional dry sand molding mixes in rammed or in slinger-placed sand molds, provides not only the very desirable low thermal expansion characteristics particularly suited for precision casting but also provides the required refractoriness for melts and alloys melted at unusually high temperatures.

H-W Flintgrain for Ceramic Shell Molds

H-W Flintgrain is an alumina-silica refractory, similar in composition to CALAMO, having the same very desirable low thermal expansion characteristics, but greater angularity of grain shape.

The angular grain shape and optimum size distribution make H-W Flintgrain ideal for securing maximum compactness in the mold. It is used with special benefit for making ceramic shell molds and for similar applications in which dense, compact mold sections of greatest volume stability at all temperatures, are of paramount importance.

Illustration of angulate shape of H-W Flintgrain (x 3)

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Westinghouse Electric Corp.
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(Kerr)
R. W. Greeff & Co., Inc.
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(Grog-O-Mix 20, Grog-O-Mix 30)
National Aluminate Corp.
(silica sol — nalcoag)
Pre-Vest, Inc.
(phosphate and gypsum binders)
Ransom & Randolph Co., The
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Riches-Nelson, Inc.
(ethyl silicate)
Alexander Saunders & Co.
(Nalcoag)
Union Carbide Chemicals Co.
(ethyl silicate, ethyl alcohol)
U. S. Stone Corp.
(water bond)
Wasco Laboratories
(wax, resin)

Investment Materials

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(ferrous and non-ferrous)
Corning Glass Works
(Glascast for molds)
Denton Precision Casting Co.
Dreifus Steel Corp.
(flask material — inconel, multimet and stainless sheet material)
Dick Ellis Co.
(Kerr)
Harbison-Walker Refractories Co.
Illinois Minerals Co.
(Amorphous pulverized silica)
Kerr Mfg. Co.
(ferrous and non-ferrous)
Lava Crucible-Refractories Co.
(refractory grains)
Niranium Products
(ethyl-silicate, high-heat water bond air setting, Cristobalite, gypsum base)
Pre-Vest, Inc.
(ferrous and non-ferrous, refractory blends for ethyl silicate binders, custom made refractory blends)
Quartz Products Corp.
(ceramic)
Ransom & Randolph Co., The
(ferrous and non-ferrous)
Alexander Saunders & Co.
(Nalcast)
Tamms Industries Co.
(hard and solt silica)
Zirconium Corp. of America
(zirconium oxide)

Pattern Materials

M. Argueso & Co., Inc.
(wax)
Axel Plastics Research Labs.
(plastic, parting compounds and mold washes)
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A Div. of Union Carbide Corp.

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DICK ELLS CO.
Los Angeles, California

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Div. of Petrolite Corp.
(wax)

Casting Supply House
(wax, plastic, pattern die materials, parting compounds and mold washes)

Centrifugal Casting Supply Co.
(wax, plastic, pattern die materials, parting compounds and mold washes)

Crestline Products Co.
(wax, plastic)

Denton Precision Casting Co.
(wax, parting compounds and mold washes)

Joseph Dixon Crucible Co., The
(parting compounds and mold washes)

Dura Commodities Corp.
(wax, plastic)

Dick Ells Co.
(wax, plastic, pattern die materials, parting compounds and mold washes)

Greenwood Corp.
(wax, pattern die materials, parting compounds and mold washes)

Harbison-Walker Refractories Co.
(parting compounds and mold washes)

J. I. Holcomb Mfg. Co.
Research Lab.
(wax)

Illinois Minerals Co.
(amorphous pulverized silica)

Kerr Mfg. Co.
(wax, parting compounds and mold washes)

Lava Crucible-Refractories Co.
(parting compounds and mold washes)

Martin Mfg. Co.
(wax, plastic)

Niranium Products
(wax, parting compounds and mold washes)

Perma-Flex Mold Co., The
(pattern die materials, parting compounds and mold washes)

Alexander Saunders & Co.
(wax)

Tamms Industries Co.
(pattern die materials)

Union Carbide Plastics Co.
(plastic)

Van Dorn Iron Works Co.
(plastic)

Wasco Laboratories
(wax, plastic, parting compounds and mold washes)

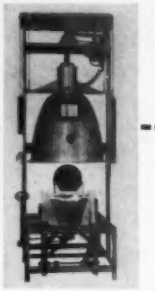
Yates Mfg. Co.
(wax)

EQUIPMENT

Casting Clean-Up Equipment

Alloy Metal Products, Inc.
(abrasive blast, cut-off wheels, barrel tumbling)

Casting Supply House
(abrasive blast, cut-off wheels, abrasive belts)



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  ask for Bulletin 1258

- **AUTOMATIC INDUSTRIAL INJECTOR**
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  ask for Bulletin 120
- **QUICK-ACTING ADJUSTABLE CLAMPS**
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Casting research on 17-4PH increases elongation 10%... costs Cannon-Muskegon customers nothing ¶ Cannon-Muskegon research has developed certain procedures for investment casting of 17-4PH that assure, consistently, the high level of properties which this alloy is capable of producing. ¶ Casting test bars in a keel block arrangement as shown here—rather than an end-gated arrangement—is one of them. Special recommendations on aging time and temperature are another. ¶ Further, Cannon-Muskegon research has demonstrated the necessity of stricter limits to provide a balanced chemistry and prevent harmful effects induced by too high or too low a content of certain elements. Keeping within these limits and following Cannon-Muskegon recommendations assures investment casters of consistently obtaining optimum performance from this fine alloy. ¶ We invite you to write for a free copy of the ICI Technical Research Report, "The Effect of Aging Time and Temperature on the Mechanical Properties of Investment Cast 17-4PH."

MASTERMET
AIR-MELTED ALLOYS

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Metallurgical Specialists • 2871 Lincoln Street • Muskegon, Michigan

For more information circle No. 80 on the Reader Service Card

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Dick Ellis Co.
(abrasive blast, cut-off wheels, barrel tumbling, abrasive belts)
Jimco Engineering Co.
(barrel tumbling)
Niranium Products
(cut-off wheels)
Norton Co.
(abrasive blast, cut-off wheels, abrasive tumbling)
Pangborn Corp.
(abrasive blast)
Alexander Saunders & Co.
(abrasive belts)

Casting Equipment

British Machines & Foundry Co.
Clino Div.
(vacuum, gravity)
Casting Supply House
(centrifugal, vacuum, gravity)
Centrifugal Casting Supply Co.
(centrifugal, vacuum)
Consolidated Electrodynamics Corp.
(vacuum)
Denton Precision Casting Co.
(centrifugal)
Ecco High Frequency Corp.
(centrifugal, vacuum)
Dick Ellis Co.
(centrifugal, vacuum, gravity)
Greenwood Corp.
(centrifugal, vacuum, gravity)
NRC Equipment Corp.
(vacuum)
New York Air Brake Co., The
(vacuum)
Niranium Products
(centrifugal)
Reed-Prentice Div.
Package Machinery Co.
(vacuum)
Alexander Saunders & Co.
(centrifugal, vacuum, gravity)
F. J. Stokes Corp.
(centrifugal, vacuum)

Crucibles

Ajax Electrothermic Div.
Ajax-Magnethermic Corp.
Alloy Metal Products, Inc.
American Refractories & Crucible Corp.
British Machine & Foundry Co.
Clino Div.
Casting Supply House
Centrifugal Casting Supply Co.
Denton Precision Casting Co.
Joseph Dixon Crucible Co., The
Electro Refractories & Abrasives Corp.
Dick Ellis Co.
Greenwood Corp.
Inductotherm Corp.
Lava Crucible-Refractories Co.
Niranium Products
Ross-Tacony Crucible Co.
Alexander Saunders & Co.
Surface Combustion Corp.
Vesuvius Crucible Co.
Zirconium Corp. of America

Furnace Refractories

Ajax Electrothermic Div.
Ajax-Magnethermic Corp.
American Refractories & Crucible Corp.
Casting Supply House
Joseph Dixon Crucible Co., The
Electro Refractories & Abrasives Corp.
Dick Ellis Co.
Greenwood Corp.
Harbison-Walker Refractories Co.
Illinois Minerals Co.
Inductotherm Corp.
Lava Crucible-Refractories Co.
Niranium Products
Norton Co.
Ross-Tacony Crucible Co.
Alexander Saunders & Co.
Zirconium Corp. of America

Furnaces: Burnout

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Clino Div.
Casting Supply House
Centrifugal Casting Supply Co.
Denton Precision Casting Co.
Dick Ellis Co.
Greenwood Corp.
Alexander Saunders & Co.

Furnaces: Melting

Ajax Electrothermic Div.
Ajax-Magnethermic Corp.
(induction)

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Electronic quality

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For more information circle No. 93 on the Reader Service Card

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British Machines & Foundry Co.
Clino Div.
(carbon arc)
Casting Supply House
(fuel fired, induction, carbon arc)
Centrifugal Casting Supply Co.
(fuel fired)
Ecco High Frequency Corp.
(induction)
Dick Ells Co.
(fuel fired)
Hauck Mfg. Co.
(fuel fired)
Hy-Rota Corp.
(induction)
Inductotherm Corp.
(induction)
Jimco Engineering Co.
(fuel fired)
Kuhlman Electric Co.
Detroit Electric Furnace Div.
(induction, carbon arc)
Lepel High Frequency Laboratories, Inc.
(induction)
New York Air Brake Co., The
(induction)
Ohio Crankshaft Co., The
Tocco Div.
(induction)
Alexander Saunders & Co.
(fuel fired, induction, carbon arc)
Schurs Oil Burner Co.
(fuel fired)
F. J. Stokes Corp.
(induction)
Surface Combustion Corp.
(fuel fired)
Zirconium Corp. of America
(fuel fired)

Pattern Equipment

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(wax injectors, plastic molding presses)
Cannon-Muskegon Corp.
(flasks)
Casting Supply House
(wax melters, wax injectors, plastic molding presses, flasks)
Centrifugal Casting Supply Co.
(wax melters, wax injectors, plastic (molding presses, flasks)
Denton Precision Casting Co.
(wax injectors, flasks)
Dick Ells Co.
(wax melters, wax injectors, flasks)
Greenwood Corp.
(wax melters, wax injectors)
Leyden Hydraulics, Inc.
(wax injectors)
Niranium Products
(flasks)
Reed-Prentice Div.
Package Machinery Co.
(plastic molding presses)
Alexander Saunders & Co.
(wax melters, wax injectors, plastic molding presses)
Sta-Warm Electric Co.
(wax melters)
F. J. Stokes Corp.
(plastic molding presses)
Van Dorn Iron Works Co.
(plastic molding presses)

Vacuum Equipment

British Machines & Foundry Co.
Clino Div.
(melting)
Casting Supply House
(degassing, investment de-airing, melting)
Centrifugal Casting Supply Co.
(investment de-airing)
Consolidated Electrodynamics Corp.
(melting)
Denton Precision Casting Co.
(investment de-airing)
Ecco High Frequency Corp.
(melting)
Dick Ells Co.
(investment de-airing)
Greenwood Corp.
(investment de-airing)
Inductotherm Corp.
(melting)
Jimco Engineering Co.
(degassing)
NRC Equipment Corp.
(degassing, investment de-airing, melting)
New York Air Brake Co., The
(degassing, investment de-airing, melting)

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410	316	AMS 5385	WI-52	713	GMR 235
347	17-4 PH	AMS 5388	Vascojet 1000	Waspaloy	Rene' 41
431				Udimet 500	

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Misco Precision Casting Company

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Alexander Saunders & Co.
(investment de-airing)
Sta-Warm Electric Co.
(melting-electric)
F. J. Stokes Corp.
(degassing, investment de-airing, melting)

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(I-B-S — Ingot, Bar, Shot)

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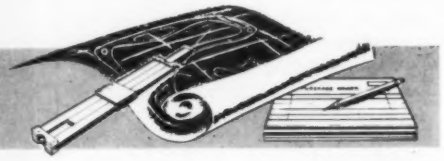
Alloy Metal Products, Inc. (I-B-S)
Aluminum Smelting & Refining Co. (I)
American Smelting & Refining Co. (I-S)
Federated Metals Div.
Apex Smelting Co. (I-B-S)
Belmont Smelting & Refining Works (I-B-S)
Beryllium Corp., The (I-B)
Brush Beryllium Co. (I-B-S)
Cerro de Pasco Sales Corp. (I)
L. E. Simmons Refining Co.
U. S. Reduction Co. (I-B-S)
United Refining & Smelting Co. (I-B-S)
Vascoloy-Ramet Corp.

Ferrous Alloys

Alloy Metal Products, Inc. (I-B-S)
Armco Steel Corp. (I-B)
Belmont Smelting & Refining Works (I-B-S)
Brush Beryllium Co. (I-B-S)
Cannon-Muskegon Corp. (I-B-S)
Casting Supply House (I-S)
Deloro Stellite (I-S)
Dick Ellis Co. (I-B-S)
Dreifus Steel Corp. (B)
Frankel Co., Inc. (I-B-S)
General Electric Co. (I)
Niranium Products (I-B-S)
Shields & Co. (S)
Vanadium-Alloys Steel Co. (I-B-S)
Vascoloy-Ramet Corp.
WaiMet Alloys Co. (I-B-S)
M. A. Young & Co. (I-S)

4th Annual

Investment Castings Directory



SECTION 3 ■ BUYERS' GUIDE

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New York, N. Y.
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Div. of Litton Industries
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All Alloy Precision Cast
118 Sheldon Ave., S.E.
Grand Rapids, Mich.
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Yonkers, N. Y.
Alloy Precision Castings Co.
2620 1st St.
LaVerne, Calif.
Arnold Foundry
Whitefield St.
Guilford, Conn.
Arrow Acme Corp.
411 N. Prospect
Webster City, Iowa
Arwood Precision Casting Corp.
321 W. 44
New York, N. Y.
Austenal, Inc.
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Chicago, Ill.
Austenal, Inc.
Div. of Howe Sound Co.
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New York, N. Y.
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Minneapolis, Minn.
Cadmet Corp.
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Detroit, Mich.
California Precision Castings, Inc.
1721 Standard Ave.
Glendale, Calif.
Castall Precision Products
1911 W. Cullerton
Chicago, Ill.
Castalloy Corp. of Illinois
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Chicago, Ill.
Casting Engineers, Inc.
2323 N. Bosworth Ave.
Chicago, Ill.
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147 W. 42
New York, N. Y.
Cooper & Schuber Co.
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Los Angeles, Cal.
Cranston Casting Co., Inc.
52 Pavilion Ave.
Cranston, R. I.
Crestline Products Co.
218 N. Fifth
Minneapolis, Minn.
Dean Casting & Mfg. Co.
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Minneapolis, Minn.
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Designed Precision Castings, Ltd.
75 Eastern Ave.
Brampton, Ont., Can.
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Hialeah, Fla.
Engineered Precision Casting Co.
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Woodside, N. Y.
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Detroit, Mich.
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Special Products Div.
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Dayton, O.
Gowin & Keleher, Inc.
82-88 Center
Middletown, Conn.
Gray-Syracuse, Inc.
Manlius, N. Y.
H.S.P. Inc.
177-181 N. Vista
Los Angeles, Calif.
Hampshire Casting Co.
11 Davis
Easthampton, Mass.
Harcast Co., Inc.
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Glenolden, Pa.
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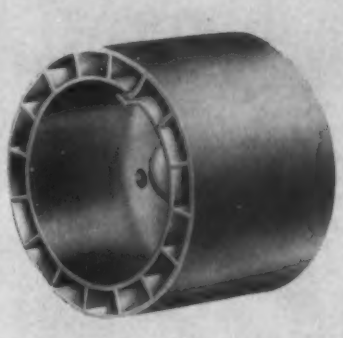

magnesium

cobalt alloy

stainless steel

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903 N. Spaulding Ave.
Chicago, Ill.
Independent Steel Casting Co., Inc.
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Berkeley, Cal.
Industrial Fine Castings Ltd.
272 Geary Ave.
Toronto, Ontario, Canada
International Nickel Co., Inc., The
67 Wall St.
New York, N. Y.
Intricast, Inc.
1 Madison St.
Loudonville, O.
Investment Casting Co.
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Springfield, N. J.
Investment Casting Co.
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Meadville, Pa.
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Burbank, Cal.
Kemtron Products Co.
750 Fulton St.
Fresno, Cal.
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Cleveland, O.
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12337 Branford St.
Sun Valley, Calif.
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New York, N. Y.
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1668 Euclid
Santa Monica, Cal.
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Long Island City, N. Y.
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Elkhart, Ind.
Kenneth Lynch & Sons
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Burbank, Cal.
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Electronicast Div.
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Pell Lake, Wis.
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614 First St., S.W.
Cedar Rapids, Ia.
Palco Industries
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Chicago, Ill.
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New York, N. Y.
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El Monte, Cal.
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Philadelphia, Pa.
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Portland, Ore.
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Toronto, Ontario, Can.
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R 5 Green St.
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Elkhart, Ind.
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Lansdale, Pa.
Shields & Co.
10 Delancy
Newark, N. J.
Sigourney Mfg. Corp.
975 Main
Waltham, Mass.
Standard Tool Co.
Hamilton St.
Leominster, Mass.
Sundstrand Machine Tool Co.
Aviation Div.
2421 Eleventh St.
Rockford, Ill.
Supreme Precision Castings Ltd.
550 Montee de Liesse
Montreal, Quebec, Canada
Tectron, Inc.
652 N. Robertson Blvd.
Los Angeles, Cal.
K. W. Thompson Tool Co.
20 Denton Ave.
New Hyde Park, L. I., N. Y.
Turbo Cast, Inc.
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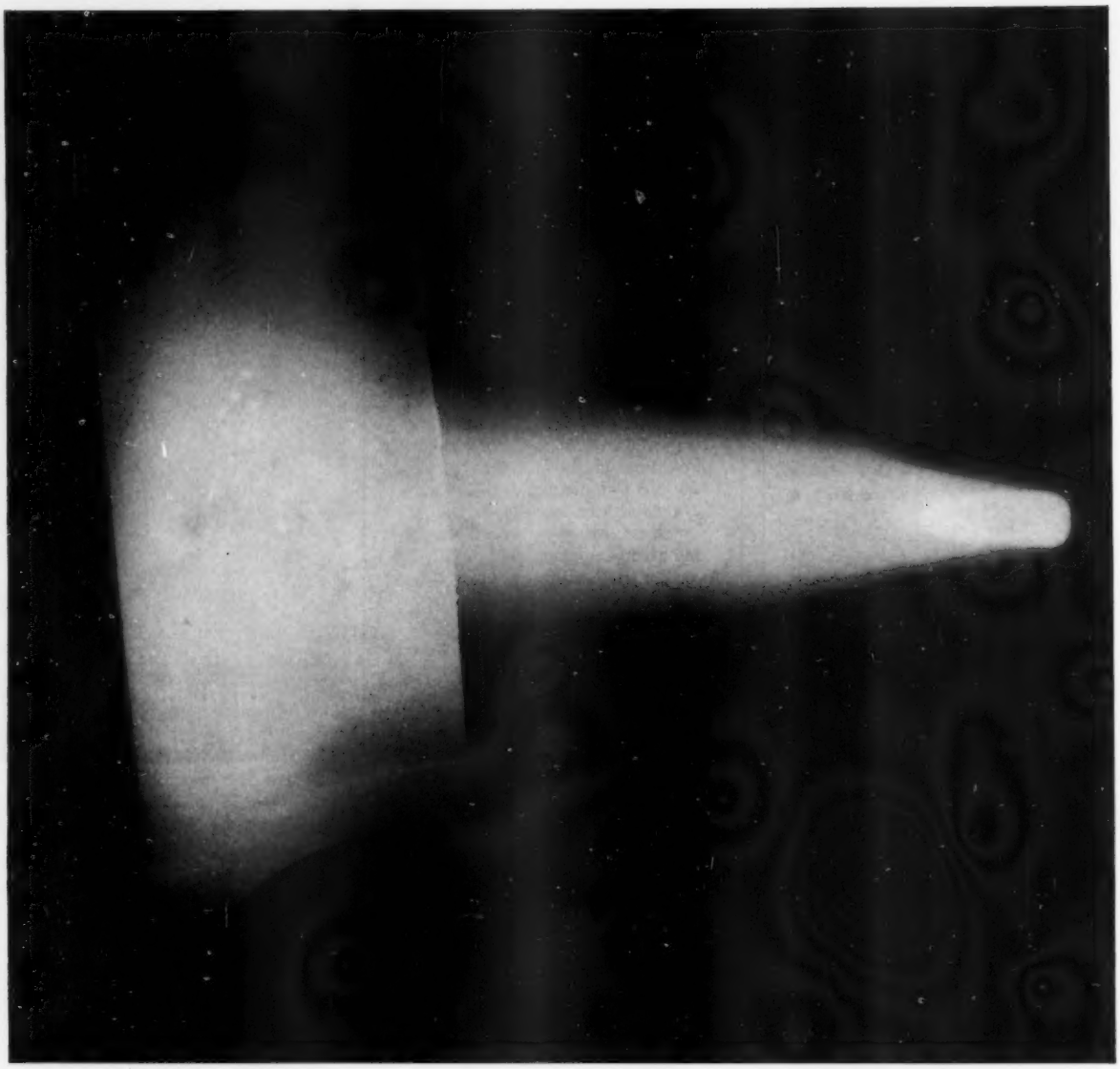

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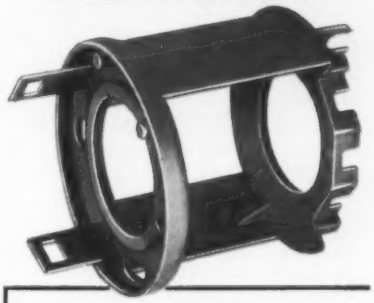

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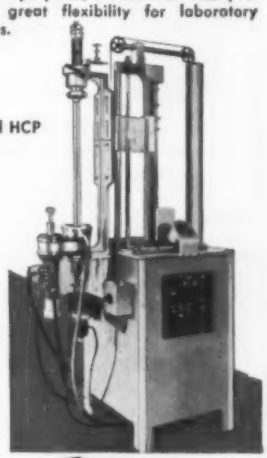

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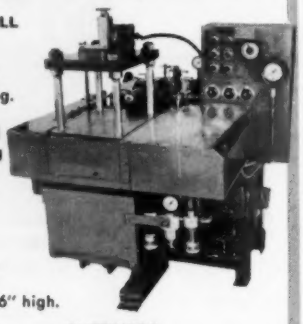

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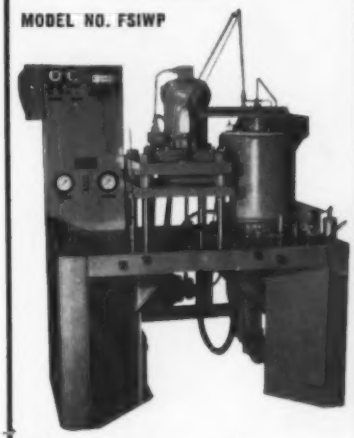

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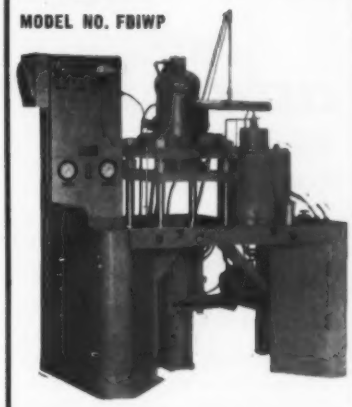

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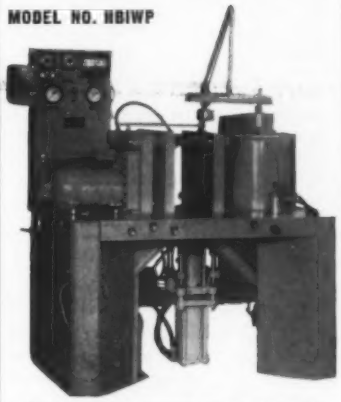

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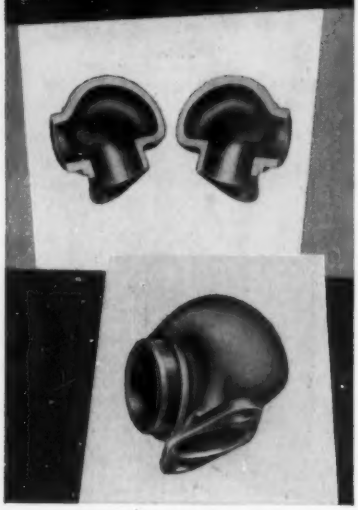

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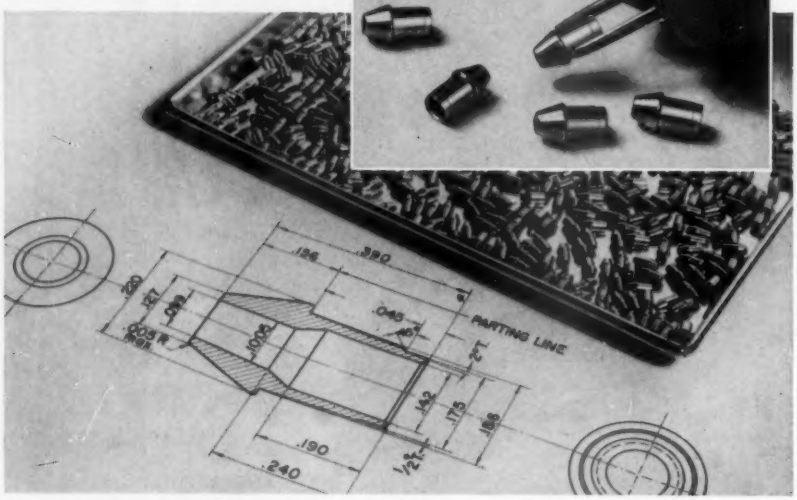

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CLEANING & PAINTING

continued from page 53

hot, cleaned parts are removed from the vapor zone of a conventional vapor degreaser. In instances where it is desirable to evaporate most of the thinner while the part is beneath the vapor zone, a supplemental heat source, such as infrared lamps or electrical induction heating units is installed. When using an air drying paint, the part leaves the machine clean, painted, dry to the touch, and ready for immediate packaging or further processing. When baking primers are used, the painted part will often be tacky, but will be free of trichlorethylene thinner. In many instances, it will be possible to apply a finish coat over the unbaked primer by conventional spray methods, and cure both the prime coat and finish coat in a single baking step.

COMPARATIVE COSTS

The objective of this study is to compare estimated costs for new, improved methods of cleaning and painting metal with costs of methods which are now in wide use. For purposes of this study, "Present Method" includes the following processing steps; (1) cleaning in an alkali washer; (2) drying; (3) painting, either in a hand-spray booth or a dip tank; and (4) oven-drying. "Improved Method" is defined as the use of a long, tunnel-type, monorail-equipped unit in which the work is vapor-degreased, painted and leveled without leaving the trichlorethylene vapor zone until the entire operation has been completed. Drying occurs as the work leaves the vapor zone, separate dryer is not required. The advantages of the Improved Method are: (1) substantial savings in initial capital investment; (2) flammability hazard virtually eliminated; and (3) operating savings through reduction in labor cost, paint and thinner consumption, and utilities requirements.

It is not the intention of this study to develop a specific cost figure but rather, by using a theoretical case, to establish a pattern which can be followed in making a comparative cost study for any operation. Both operating costs and capital investment must be considered when estimating the true cost of a cleaning and painting operation (Table I).

It is recognized that accounting practices vary widely and that unit costs, such as steam prices, may differ from one locality to another. In using this sample study it will be necessary to alter the figures to suit the individual case.

In studies where this method of cost analysis has been applied, the economic advantages of using a trichlorethylene-based system for cleaning and painting metal have been confirmed.

TABLE I

CLEANING AND SPRAY PAINTING HOURLY OPERATING COSTS

Present Method: Includes alkali washing, oven-drying, hand-spray application and conventional paint, and oven-drying steps.

I. Cleaning	Present Method	Improved Method
A. Solvent or Chemicals	$ 0.38	$ 2.28
B. Steam	2.04	0.36
C. Water	0.01	0.03
D. Power	0.22	0.03
E. Oper. Labor	0.33	0.33
F. Maintenance	0.41	0.34
G. Taxes, Deprec., Ins.	0.49	0.40
H. Rejects	——	——
J. Waste Disposal Costs	——	——
K. Operating Cost	$ 3.88	$ 3.77
L. Investment Carrying Cost	2.20	1.31
M. Subtotal—Cleaning Cost	$ 6.08/hr.	$ 5.08/hr.
II. Painting		
A. Paint	$36.00	$24.00
B. Thinner	4.80	(3.71 Cr)
C. Steam	1.80	0.18
D. Water	0.01	0.02
E. Power	0.13	0.02
F. Oper. Labor	14.40	7.32
G. Maintenance	1.63	0.34
H. Taxes, Deprec., Ins.	1.16	0.40
J. Rejects	1.00	1.00
K. Operating Cost	$60.93	$29.57
L. Investment Carrying Cost	8.54	3.40
M. Subtotal—Painting Cost	$69.47	$32.97

Improved Method: Includes sequential vapor degreasing and flow-coat application of trichlorethylene-thinned paint.

III. Summary:	Present Method	Improved Method
(I-M) Cleaning	$ 6.08	$ 5.08
(II-M) Painting	69.47	32.97
TOTAL HOURLY MANUFACTURING COST:	$75.55	$38.05
COST/UNIT IS THEN:	$ 0.16	$ 0.08
COST/1000 SQ. FT. IS THEN:	$18.00	$ 9.06

COST REDUCTION IS 50%

INVESTMENT NEEDED

I. Cleaning	Present Method	Improved Method
N. Installed Equipment	$ 21,000	$15,000
P. Floor Space	5,300	2,900
R. Utilities Allocation	11,200	2,000
S. Working Capital	6,500	6,300
T. Cleaning Investment	$ 44,000	$26,200
II. Painting		
N. Installed Equipment	$ 50,000	$15,000
P. Floor Space	10,800	2,900
R. Utilities Allocation	8,900	1,000
S. Working Capital	101,000	49,200
T. Painting Investment	$170,700	$68,100
III. Summary: (I-T) Cleaning	$ 44,000	$26,200
(II-T) Painting	170,700	68,100
TOTAL	$214,700	$94,300

INVESTMENT REDUCTION IS 56%

USEFUL LITERATURE, CATALOGS, MANUALS

any of these technical publications may be obtained by circling the numbers on the Reader Service Cards facing Page 96

PROCESSES

120 Sinterings — BROCKWAY PRESSED METALS, INC. — Technical data on self-lubricating metal parts. Includes listing of physical properties.

121 Investment Castings — ILLINOIS PRECISE CASTING CO. — 12-page technical manual on the process.

122 Sinterings — GENERAL SINTERING CORP. — Technical data on the process. Includes tabular listing of iron base and copper base alloys.

123 Investment Casting — MISCO PRECISION CASTING CO. — Engineering report on the Mono-Shell Process that offers improved quality for larger castings.

124 Sinterings — ASCO SINTERING CORP. — Technical literature on self lubricating bearings, soft iron magnetic parts, porous metal filters, and machine parts.

125 Investment Castings — ENGINEERED PRECISION CASTING CO. — Engineering data folder on precision investment castings.

126 Investment Castings — ROUSCH MFG. CO. INC. — Technical data folder on intricate design and thin wall castings.

MATERIALS & EQUIPMENT

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128 Die Casting Molds — DETROIT MOLD ENGINEERING CO. — A list of standards that gives the molder added savings in mold and production costs.

129 Beryllium Oxide — BRUSH BERYLLIUM CO. — 12-pages of technical data on the properties, chemical analysis, and applications of UOX Beryllium Oxide.

130 Flame Ceramics — CONTINENTAL COATINGS CORP. — Engineering report on this process that protects metals up to 5500 F.

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132 Molybdenum — UNIVERSAL-CYCLOPS STEEL CORP. — Complete pricing schedule for molybdenum and molybdenum-titanium alloys.

133 Extruded Pipe — KAISER ALUMINUM & CHEMICAL SALES, INC. — Tabular data on the performance characteristics of extruded aluminum pipe for the process industries.

135 Fast Heating — A. F. HOLDEN CO. — 48-page engineering report on a luminous wall combustion system for gas-fired, infrared heat treating furnaces.

136 Plunger Lubricant — DIE CASTING "ID" CORP. — Technical data on a die casting plunger lubricant for extreme temperature conditions.

137 Nitrogen Generator — C. I. HAYES, INC. — Data sheet on a generator that produces 99.99% pure inert gas at low cost.

138 Permanent Magnets — CRUCIBLE STEEL CO. OF AMERICA — 12-page technical report on non-metallic ceramic permanent magnets.

139 Abrasion-Resistant Alloy Steel — JONES & LAUGHLIN STEEL CO. — 8-pages of engineering data on Jalloy, a heat-treated and abrasion-resistant alloy steel.

140 Stainless Steels — COOPER ALLOY CORP. — 12 page bulletin on stainless steels in rockets and missiles. Includes alloy data.

141 Retaining Rings — RAMSEY CORP. — Complete price listings on single and two-turn wound Spirolox Rings and on stamped Circolox Retaining Rings.

142 Diamond Dressing Tool — PERMATTACH DIAMOND TOOL CO., INC. — Technical data on precision diamond dressing tools.

FINISHING

143 Media Storage — TECHLINE DIV., WHEELABRATOR CORP. — Technical literature on bins and pans for storage and handling of barrel finishing media.

144 Metal Finishing Systems — ALLIED RESEARCH PRODUCTS, INC. — Technical data file on process engineered equipment and systems for metal finishing.

145 Tumbling Compounds — FINGER LAKES CHEMICAL CO. — Technical literature on 3 barrel finishing compounds: neutral, alkaline, and acid.

146 Aluminum Finishing — FREDERICK GUMM CHEMICAL CO. — 15-page technical discussion of different problems concerned with finishing aluminum.

147 Finishing News — OAKITE PRODUCTS INC. — The latest issue of the Oakite News Service contains information on cleaning materials and methods.

148 Corrosion Inhibitor — ENTHONE INC. — Technical data on Entek CU-55, a tarnish and corrosion inhibitor for copper and brass.

149 Copper Brightener — ALLIED RESEARCH PRODUCTS, INC. — Engineering data on Isobrite 623, a copper addition agent for semi-bright buff cyanide copper plating solutions.

See Special Summary of Technical Literature on Sinterings, page 80

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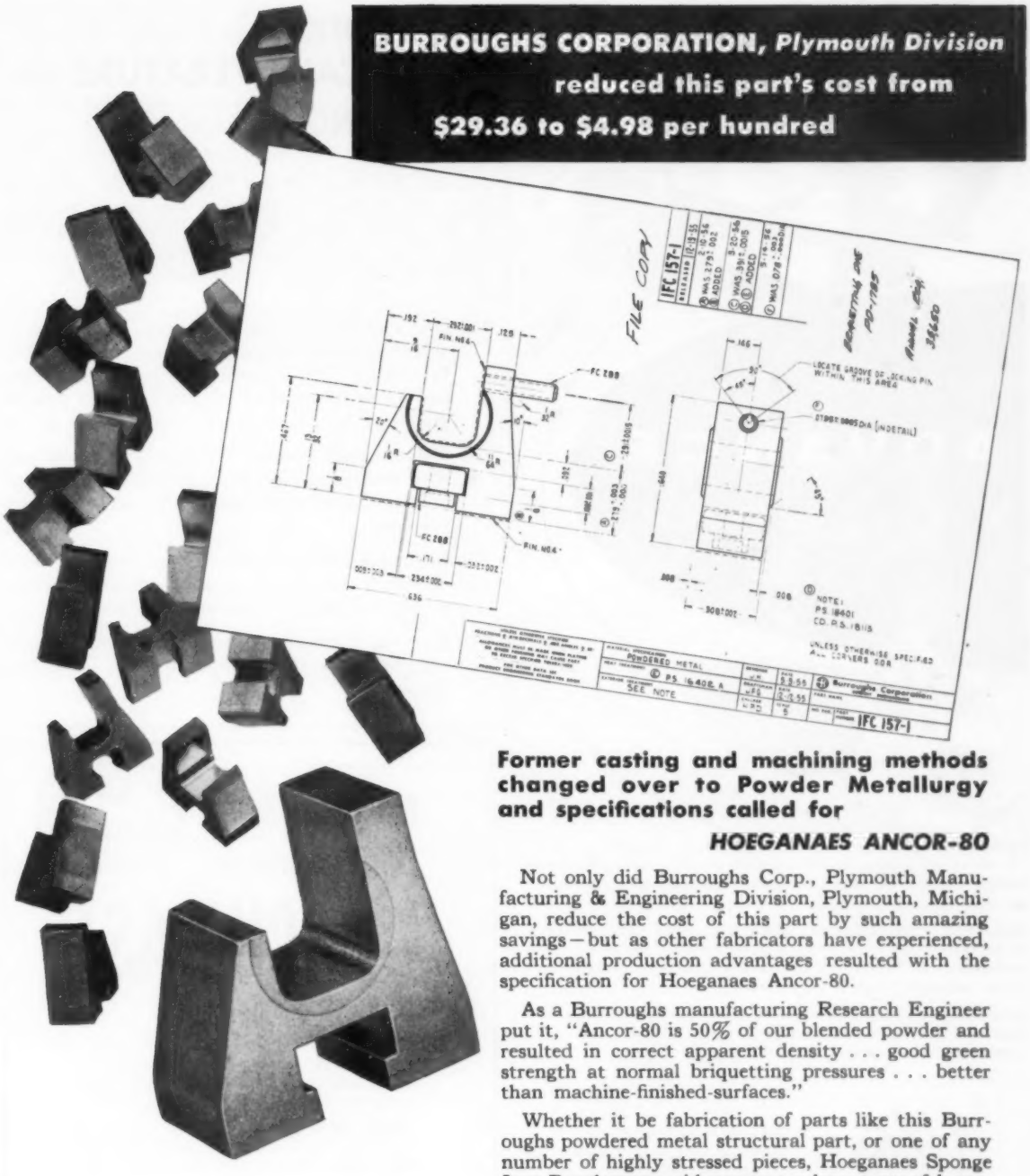

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162 Iron Powders — ALAN WOOD STEEL CO. — A series of technical data sheets on iron powders. Includes: Processing data, screen analysis, powder data, and chemical analysis for the various powder grades.

163 Stainless Steel Powders — HOEGANAES SPONGE IRON CORP. — 20-pages of technical data, in chart form, on pre-alloyed stainless steel and high alloy powders.

164 Electric Kilns — HARPER ELECTRIC FURNACE CORP. — Technical literature on all types of kilns: pusher, car bottom, continuous car and box.

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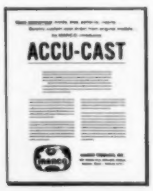

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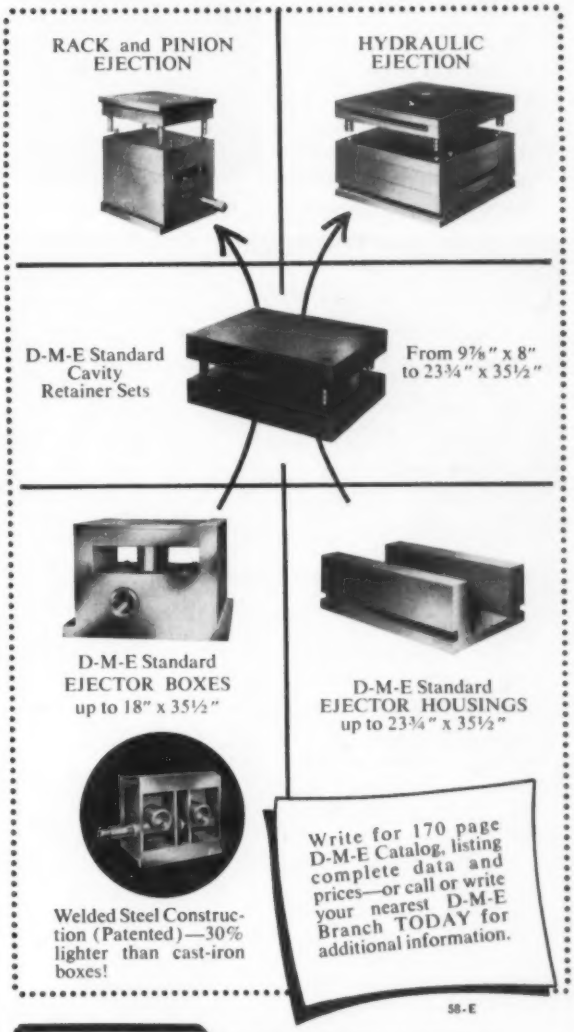
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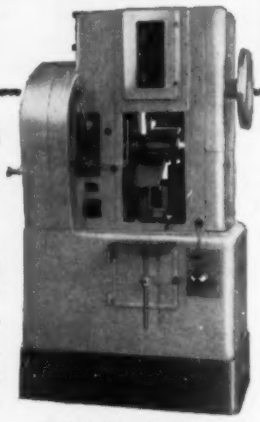

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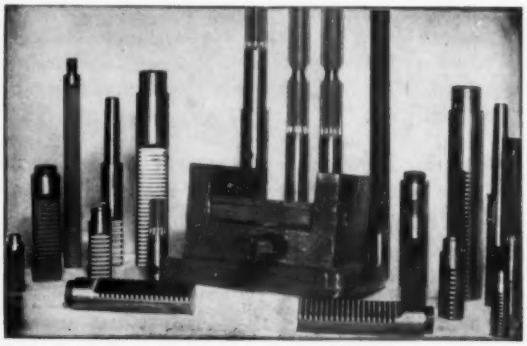

Standardized To Mate and Interchange With Each Other For Longer Wear At Less Cost.

——We Welcome Your Inquiries——

PEERLESS GEAR & MACHINE CO.

140 E. WAYNE STREET
DUNKIRK, OHIO
TEL. 3101

Precision Products Since 1921

*Trademark Registered

For more information circle No. 62 on the Reader Service Card

189 **Steel Powders** — VANADIUM-ALLOYS STEEL CO. — 68-page Tool Steel Guide contains a special section on prealloyed steel powders.

190 **Prealloyed Steel Powders** — VANADIUM-ALLOYS STEEL CO. — 3 technical reports. 1. Stainless Steel Powder for Mechanical Parts; 2. Mechanical properties of Stainless Steel Powder; 3. Technology of prealloyed Stainless Steel Powders.

191 **Tooling** — VANADIUM-ALLOYS STEEL CO. — Technical data sheets on tooling for powder metallurgy.

192 **Stainless Steel Powder** — UNION CARBIDE CORP. — Specification sheets on a stainless steel powder mix that can be used to produce sinterings of better than 95% theoretical density.

193 **Intermetallics** — UNION CARBIDE CO. — Series of technical data sheets on intermetallics that are available in powder form: Chromium boride, chromium carbide, columbium carbide, molybdenum disilicide, etc.

194 **Powders** — FOOTE MINERAL CO. — Technical data sheets on nickel powder, atomized iron, and electrolytic iron powder.

195 **Iron Powder** — EASTON METAL POWDER CO., INC. — Engineering data on low cost, high quality, RZ Iron Powder.

196 **Compacting Presses** — F. J. STOKES CORP. — Technical bulletins on rotary and single punch presses.

197 **Presses** — F. J. STOKES CORP. — Technical data sheets on single-station multiple motion presses, a 20-ton capacity single action press, and dual-pressure hydraulic compacting presses.

198 **Powder Metallurgy** — F. J. STOKES CORP. — 34-page engineering report on "Powder Metallurgy Today." Includes general and special applications and mechanical characteristics.

199 **Sinterings** — POWDERCRAFT CORP. — Technical data on machine parts and bearings.

200 **Specifications** — POWDERCRAFT CORP. — Military specifications for sleeve bearings, and oil-impregnated sintered thrust washers.

201 **Copper-Alloy Powders** — FEDERAL-MOGUL DIV. — Technical data on low oxide copper-alloy powders.

202 **Powders** — CHARLES HARDY, INC. — Data sheet lists metal powders that are carried in stock.

203 **Iron Powders** — REPUBLIC STEEL CORP. — Special technical reports on carbon compatible iron powders.

204 **Compacting Presses** — BALDWIN-LIMA-HAMILTON CORP. — Technical data, specifications on a complete line of compacting presses.

Eliminate pinhole porosity and oxide inclusions in aluminum castings with

Foseco DEGASERS

This bulletin tells you how. Send for your free copy today.

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FOUNDRY SERVICES, INC.
2000 Bruck Street, Columbus 7, Ohio

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6 GOOD REASONS
Why You Should Specify
MERRIMAN POWDERED METAL PARTS

1. HIGHEST QUALITY — ALL WAYS
2. GUARANTEED TO FIT
3. DIMENSIONALLY ACCURATE
4. PROVEN PERFORMANCE
5. LOW COST
6. FASTEST DELIVERY

Originators of Sintered Helical Gears.

High Density, precision structural parts from powdered metal in
Brass, Bronze, Copper, Nickel Silver Steel, Iron and Iron Alloys. Copper Infiltration

POWDERED METAL DIVISION
MERRIMAN BROS., INC.
185 Amory Street Boston 30, Mass.
REPRESENTATIVES IN PRINCIPAL CITIES
183 So. Chatsworth - 301 St. Paul, Minn.
739 Laurelton Road Rochester 9, N. Y
26018 West Seven Mile Road Detroit 19, Mich.

For more information circle No. 56 on the Reader Service Card

D-C CASTING

continued from page 38

billet or slab meets with the most rigid specifications controlling gas content.

Almost all the difficulties of continuous casting of extrusion billets have been gotten around. This goes for copper, brass, bronze, or copper-nickel alloys. Billets from 3 in. to 15 in. diameters are cast on a production basis and in any length. Hollow billets, produced by casting around a cooled mandrel are popular. They are cast in all sizes and allow the extrusion of large hollow shapes without proportionately increasing the extrusion pressure.

VARIABLE LENGTHS

For the producer of extrusions, an added advantage of D-C casting is that the billet length can be varied in accordance with individual die requirements. This avoids producing random lengths of extrusions with large scrap losess.

When casting extrusion billets and wire bars, the cross-section is usually uniform enough so that cooling rates in all directions are the same. In rolling mill slabs, however, the width is always greater than the thickness. For best metallurgical structure in these slabs the ratio of thickness to width should be under 1:6 if the thickness is 5" or less. Over 5" thickness the ratio may be increased to 1:8. On very thin slabs, the minimum thickness is determined by the pouring spout which must go between the faces of the mold.

TOLERANCES

D-C billets, either continuously cast or semi-continuously cast can be held to dimensional tolerances of ±1/32"; corners held to 90°, and the surface good enough so that no scalping, grinding or machining is needed.

The operator can change the grain structure and orientation of the castings because he has close control over metal temperatures, casting speeds and cooling rates. Depending upon the ultimate use of the casting, he can obtain every combination from a fine, dense, homogeneous grain structure distributed evenly throughout the casting to a coarse, heterogeneous one.

The economics of continuous casting vs. conventional shell mold casting are attractive. Casting temperatures may be somewhat lower. Losses due to volatilization of alloying constituents are lower. Scrap loss due to piping, gates, etc. are generally under 1%. The speed of cooling reduces segregation of alloying constituents with resulting lower analysis costs and fewer scrapped castings.

Shop operating costs also can show a marked reduction. The melting costs are about the same as any other melting shop. The cost of running the machine itself, i.e. necessary pumps and motors, is insignificant, the cost of molds on a per pound of metal produced basis is very small, as is the need for capital investment in spare parts and supplies. Since a D-C casting machine requires only one operator even for multi strand casting, the savings in direct labor, again on a pounds produced per man hour basis, are considerable.

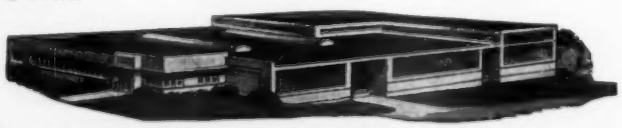
You can benefit by Milwaukee's 50 Years' Service to Industry

50th ANNIVERSARY 1909-1959

Since 1909, it has been the privilege of the Milwaukee Die Casting Company to work with manufacturers of a wide variety of products ... from mechanical pencils to airplanes ... in applying the die casting process to their problems of parts design and production. In those 50 years, Milwaukee has pioneered many of the developments which have since become standard practice.

If you wish to benefit by our 50 years of continuous service to industry coupled with the advantages of our modern die casting plant, we invite your inquiries.

Milwaukee operates under the Certified Zinc Plan of the American Die Casting Institute.



MILWAUKEE DIE CASTING COMPANY
4146 N. HOLTON STREET • MILWAUKEE 12, WISCONSIN
Established 1909

AS-9701

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INCREASE YOUR PRODUCTION— *Reduce your costs with*

DORSEY PISTON AND CYLINDER LUBRICATOR

for aluminum cold chamber die casting machines

- SAVE LUBRICANT
- PRECISE LUBE CONTROL
- REDUCE DOWN TIME
- FEWER REJECTS
- INCREASE PLUNGER AND CHAMBER LIFE

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WESTBROOK MFG. CO.
P.O. Box 231 — St. Joseph 2, Michigan

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Johnson
Ledaloyl Powder Metallurgy

Bronze or Iron
Bearings... Bushings... Parts
Offer Many Important Savings

Pre-Lubrication—The porous structure of Johnson Ledaloyl acts as a reservoir for the lubricant, providing sufficient oil during operation . . . storing it when at rest. This feature often eliminates costly lubricating devices and systems, guards against neglect and assures longer operating life of the unit.

Formed to size—The manufacturing process of Johnson Ledaloyl is essentially a forming and sintering operation. This eliminates machining, prevents scrap, yet provides accuracy at a low unit cost. Uniformity of each bearing, or part, cuts assembly time to a minimum. These are but two of the many money-saving features of Johnson Ledaloyl bearings, bushings, and structural parts. Let us show you how to design your product to take full advantage of this economy yet gain greater performance and longer service life. No obligation of course. Write for literature today.

This literature free upon request.

Johnson Bronze

770 South Mill Street • New Castle, Pa.

Subsidiary: Apex Bronze Foundry Co., Oakland, California

JOHNSON Bearings

For more information circle No. 65 on the Reader Service Card

INDUSTRY NEWS

continued from page 14

SHUMAN APPOINTED HITCHINER AGENT

William H. Shuman, formerly sales manager of HITCHINER MFG. CO., INC., will represent Hitchiner as exclusive sales engineering agent in New England. Shuman, who now has his own sales engineering organization, will supplement Hitchiner's line of investment castings with other related products.

SUTTON TO DELIVER TWO NEW PRESSES

SUTTON ENGINEERING CO. is building two new hydraulic extrusion presses for delivery later this year. One, a 1250/1500-ton horizontal hydraulic extrusion press, is being built for Saramar Aluminum Co.'s expanded program of extruding aluminum sections at Youngstown, Ohio. The other, a 600-ton horizontal press, will be used by Argonne National Laboratory, Lemont, Ill., for the extrusion of nuclear materials.

CRUCIBLE NAMES WALTON METALLURGY DIRECTOR

WALTON

E. T. Walton has been named director of metallurgy at CRUCIBLE STEEL CO. OF AMERICA. He succeeds D. I. Dilworth, who resigned. Walton, who joined Crucible in 1923, will continue to hold the position of manager of customer technical services.

ASARCO'S ALTON PLANT IN VOLUME PRODUCTION

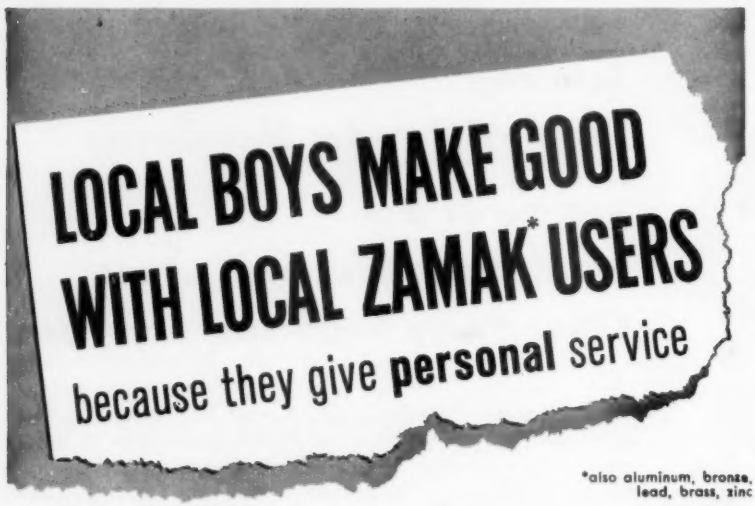
AMERICAN SMELTING AND REFINING CO. is now in volume production of aluminum alloys at its new secondary aluminum smelter in Alton, Ill. The plant, which has a production of 72 million pounds of aluminum ingot annually, is the largest smelter built specifically for the conversion of aluminum scrap into alloy ingot.

DEMRICK ON PMPMA BOARD

Carl J. Demrick, president of the Amplex Div., Chrysler Corp., has been named to serve on the board of directors of the POWDER METALLURGY PARTS MANUFACTURERS ASSOCIATION. Demrick will fill the unexpired board term of Col. C. J. Trichel, who has assumed new duties at Chrysler Corp.

PUBLISHES MANUAL ON DIE CASTING

AMERICAN CHARCOAL CO. has published a 450-page technical manual for the die-casting industry. Titled *A Visit with 500 Die-Casters*, it has the latest technical information on all phases of die casting, plus hundreds of tricks-of-the-trade. The manual, which was supervised by Ed Day, will be distributed to contributors and certain die-casting companies and personnel. All other copies will be available at $10.00 each.



At HB&S you can

- **pick up the phone and get the answer to your question** on the spot
- **call an order in for** same day shipment, **in an emergency**
- **receive palletized delivery to any point** within your plant **and the many other big little things that help you produce a better product at lower costs.**

At HB&S you get big-order, big company attention. Service is individualized to fit **your** needs . . . specifically **engineered** to meet **your** requirements.

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Spectrographic analysis of all production

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Start-to-finish quality control for alloys

100% on spec.

And yours for the asking Henning's Pocket Guide to Better Casting

Write TODAY for your copy of "Die Casting with Zinc Base Alloys" explaining the factors influencing the production of sound castings and the causes of faults and defects.

HENNING BROS. & SMITH, INC.

91-117 Scott Ave., at Randolph St., Brooklyn, N. Y.
Smelters and refiners of aluminum, bronze, brass, zinc, lead
Dependable service since 1922

For more information circle No. 36 on the Reader Service Card

NEW PRODUCTS

continued from page 20

TEMPERATURE INDICATORS, CONTROLLERS

FISHER & PORTER CO. — Line of indicators, controllers and transmitters feature corrosion-proof fiber glass cases. They are suitable for temperatures ranging from −400 to +1000 F.

Circle No. 263 on Reader Service Card

THERMOCOUPLE EXTENSION CABLE

THERMO ELECTRIC CO., INC. — Thermo-Cable is a polyvinyl insulated multi-conductor cable for 6 to 56 pairs of thermocouple conductors. The outer jacket of the cable will resist moisture, abrasion, heat, and chemical action.

Circle No. 270 on Reader Service Card

COMPOUNDS FOR CONVERSION COATINGS

MACDERMID INC. — Macromates are a new group of compounds for producing chromate conversion coatings on zinc and cadmium plate, zinc base die castings and aluminum. They are available in colors from clear to olive drab.

Circle No. 271 on Reader Service Card

SCREEN SEPARATOR

RAMPE MFG. CO. — Model SS-3 is a flexible, heavy-duty machine for fast separation of tumbling media and processed parts. Features include a variable speed drive, adjustable loading angle, and interchangeable mesh 24″ x 48″ screens.

Circle No. 272 on Reader Service Card

ABRASIVE BELT POLISHING

DEVINE BROTHERS CO. — The VR Bench Lathe, designed for mounting either on a bench or pedestal, can be used for abrasive belt polishing. The unit features a wide selection of speeds.

Circle No. 273 on Reader Service Card

HIGH VACUUM AIR-COOLED PUMP

LEIMAN BROS., INC. — Six sets of dual vanes provide positive high-pressure oil seal, and the pump utilizes a patented radiator oil-cooling system. The pump, Model 106, provides a vacuum of 29.9″ Hg. in continuous operation, at an average temperature of 200 F. It has a capacity of 50 to 105 c.f.m.

Circle No. 274 on Reader Service Card

continued on next page

Bunting makes the "almost impossible" bearings and parts

The photograph shows a sintered bronze bearing used in an exceedingly popular home laundry drier. It offers several unusual features, some of which you may find useful in designs you are considering as sintered parts. In the first place because the splines on the O.D. of the bearing abut the back of the bearing flange, this is a part which would be almost impossible to produce by machining but can readily be produced by powder metallurgy.

Second, the splines do not extend the full length of the bearing but the density of the splines must be the same as the remainder of the bearing. This requires intricate and unusual tooling and understanding of the problem which is one of the reasons why this manufacturer put his design in the hands of Bunting.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

The Bunting Brass and Bronze Company
Toledo 1, Ohio EVergreen 2-3451 Branches in Principal Cities

Bunting®

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

For more information circle No. 11 on the Reader Service Card

PLAST-IRON POWDERS

REPLACE WITH

B-280

Standard 80 Mesh Iron Powder

IMPROVE WITH

B-281

Phos Enriched
80 Mesh Iron Powder

ECONOMIZE WITH

B-270

35 Mesh Reduced Iron Powder

PM 9d

Send for Technical Data and Working Sample

PM PLASTIC METALS

PLASTIC METALS

Division

National-U.S. Radiator Corporation

3459 BRIDGE STREET

JOHNSTOWN, PA.

Circle No. 58 on the Reader Service Card

NEW PRODUCTS

continued from page 87

EXHAUST HOOD FOR ELECTRIC FURNACES

PANGBORN CORP. — Dust, fume and smoke control for electric furnaces is made possible with this exhaust hood. The hood features simple design and operates with reduced air volume and minimum interference with charging, pouring or other furnace operations.

Circle No. 242 on Reader Service Card

INSPECTION SYSTEM

FERRO MACHINE & TOOL CORP. — Portable magnetic inspection system for detecting surface and subsurface defects in ferrous metal parts. The unit demagnetizes the part after inspection. It will locate discontinuities even through painted or plated surfaces.

Circle No. 243 on Reader Service Card

LONG STROKE DRILLING UNITS

HYPNEUMAT, INC. — Long stroke automatic drilling and tapping units that range in strokes up to 25". They will supply power for drilling and tapping operations, plus multi-diameter step machining, etc. The units can be interlocked with indexing tables, automatic work feeders and fixtures.

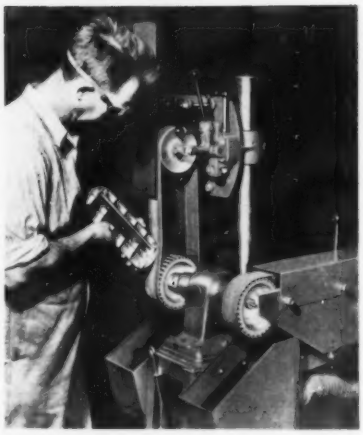
Circle No. 244 on Reader Service Card

MULTIPLE SPINDLE DRILLING

PRECISION TOOL MFG. CO. — The Deka-Drill will drill or tap up to 12 holes simultaneously. At 60 S.F.M. and 1½" feed per minute, the drilling capacity is: Six — ¾"; ten — 5/16"; or fourteen ¼" holes. At 75% thread, 20" per minute feed, the tapping capacity is five 5/16-18; eight ¼-20; twelve 10-32; and fourteen 8-32 taps.

Circle No. 251 on Reader Service Card

BELT GRINDERS



ROCKWELL MFG. CO. — A complete line of low-cost 2½" belt grinders. The units feature fast, efficient grinding, buffing and deburring. In addition to the four standard setups, a variety of accessories are available for building special job setups.

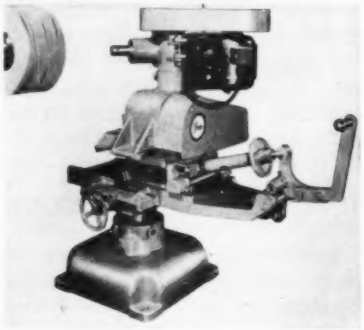
Circle No. 247 on Reader Service Card

VACUUM FURNACE

RICHARD D. BREW & CO., INC. — Model 300 is a laboratory type high vacuum heat-treating furnace. Features a 1" diameter by 3" high hot zone for operation at 2500 C. The unit has a high capacity pumping system and low operational cost.

Circle No. 248 on Reader Service Card

WORK HOLDER FOR POLISHING & BUFFING



DIVINE BROS. CO. — The PG Semi-Matic Work Holder holds the part against the wheel, turning it and oscillating it across the wheel. All the operator has to do is load the work and advance it to the wheel.

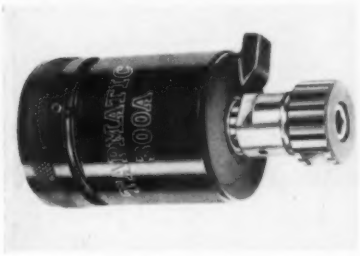
Circle No. 250 on Reader Service Card

5-POSITION TURRET HEAD

CHICAGO QUADRILL CO. — Unit makes possible 5 different operations on one drill press — drill, ream, countersink, counterbore, tap — without changing set ups. The heads are available in sizes to fit most any drill press.

Circle No. 245 on Reader Service Card

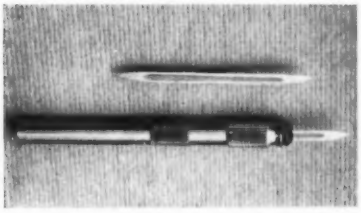
TAPPING ATTACHMENT



TAPMATIC CORP. — The 300A is a high speed tapping attachment, capable of continuous operation at speeds up to 2500 r.p.m. The unit features an axial floating drive spindle and a spring loaded ball clutch. Tap stops instantly when it becomes dull, loaded or bottoms in blind hole tapping.

Circle No. 246 on Reader Service Card

SCRAPER & DEBURRING TOOL



TITAN TOOL SUPPLY CORP. — A vest pocket size scraper and deburring instrument. The fully retractable cutting blade can be adjusted to any required cutting length up to 3 inches.

Circle No. 254 on Reader Service Card

TEMPERATURE CONTROL

UNITED ELECTRIC CONTROLS CO. — The E36N is a low cost remote bulb temperature control. It will control and indicate temperatures of gases and liquids over a variety of ranges between -100 F. & + 600 F.

Circle No. 252 on Reader Service Card

LEAD SCREW TAPPER

JARVIS CORP. — An automatic adjustable pitch lead screw tapper that is adaptable to any drill press table. The unit has 4 speed pulleys, 575, 958, 1473 and 2415 RPM.

Circle No. 253 on Reader Service Card

FIBERGLASS-LINED PLATING TANKS

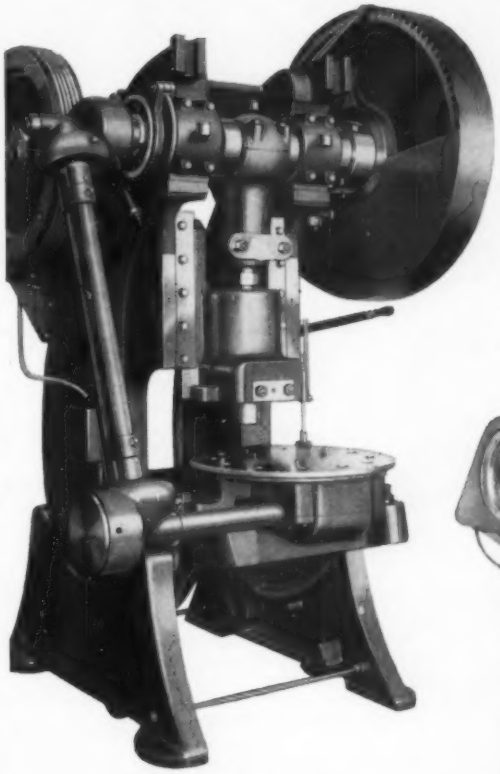
THE MYCO CO. — The liners consist of built-up laminated, seamless fiberglass and plastic resin, formed and set under heat and pressure. They are available in a variety of sizes and shapes for solution, plating, cleaning and finishing.

Circle No. 290 on Reader Service Card

Modern FEDERAL Dial Feeds give you

automation at less cost!

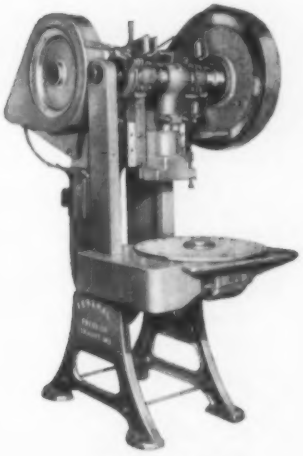
—eliminate specialized and more costly equipment!



No. 7 Dial Feed
Gear Driven. Capacity, 80 tons.

Federal Dial Feeds are your answer to greater production at lower costs. Equipped with special jigging, automatic feeds and ejectors, their applications are virtually unlimited and the need for specialized, more costly equipment often eliminated. (Example, one manufacturer increased production 600%.)

Add Federal's quality features and workmanship . . . and you've got a winner. Investigate Federal Dial Feeds for your operations. Gear or chain driven with cam-type indexing mechanisms. Sizes range from 6 to 80 tons.



No. 3 Dial Feed
Chain Driven. Capacity, 26 tons.

FEDERAL PRESS COMPANY
912 Division St., Elkhart, Indiana

FEDERAL DIAL FEED PRESSES
33 Years' Experience in Dial Feed Engineering and Construction

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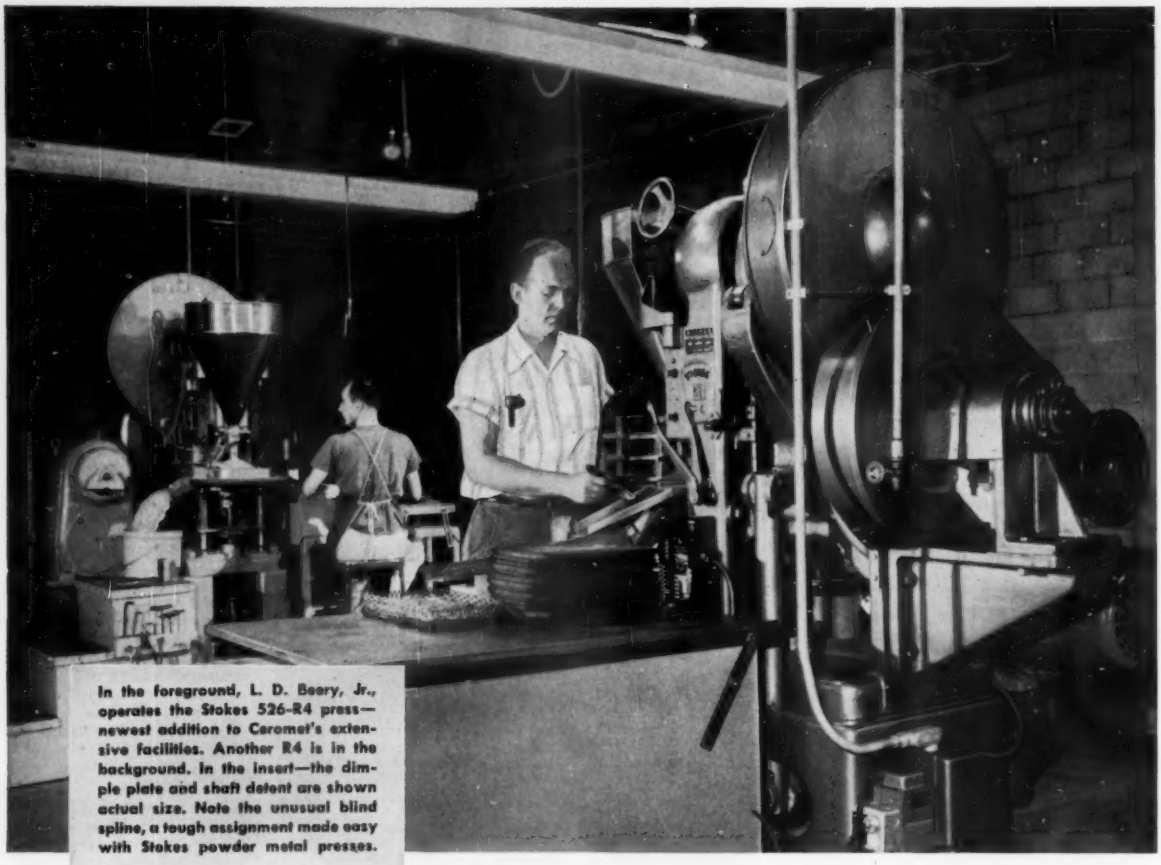
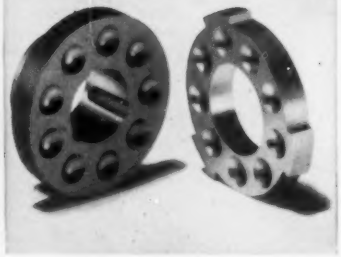


In the foreground, L. D. Beery, Jr., operates the Stokes 526-R4 press—newest addition to Ceromet's extensive facilities. Another R4 is in the background. In the insert—the dimple plate and shaft detent are shown actual size. Note the unusual blind spline, a tough assignment made easy with Stokes powder metal presses.



CEROMET INC., cuts precision tool parts costs 60% with STOKES POWDER METAL PRESSES

Ceromet Inc., La Puente, California manufacturer of powdered metal products, makes dimple plates and shaft detents for a major West Coast precision tool company. The combination of sintered metal and Stokes compacting presses were chosen for this job to provide fast, economical production of quality, close-tolerance parts. Both pieces are produced at the rate of 25 per minute, sintered in a dissociated ammonia atmosphere, and case hardened .020" in a carbo-nitriding furnace.

Stokes industrial compacting presses produce these parts at an estimated 60% cost reduction over machining—make possible the production of efficient designs not even possible by older and costlier methods. The reproducibility of dimensional control is within 1%—thanks to powder metallurgy techniques and Stokes precision equipment.

Stokes Engineering Advisory Service will be glad to consult on your specific powder metal applications—to help design parts, punches and dies, or complete production facilities. Additional technical information on the entire Stokes line of industrial compacting presses will be sent you on request.

Powder Metal Press Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES

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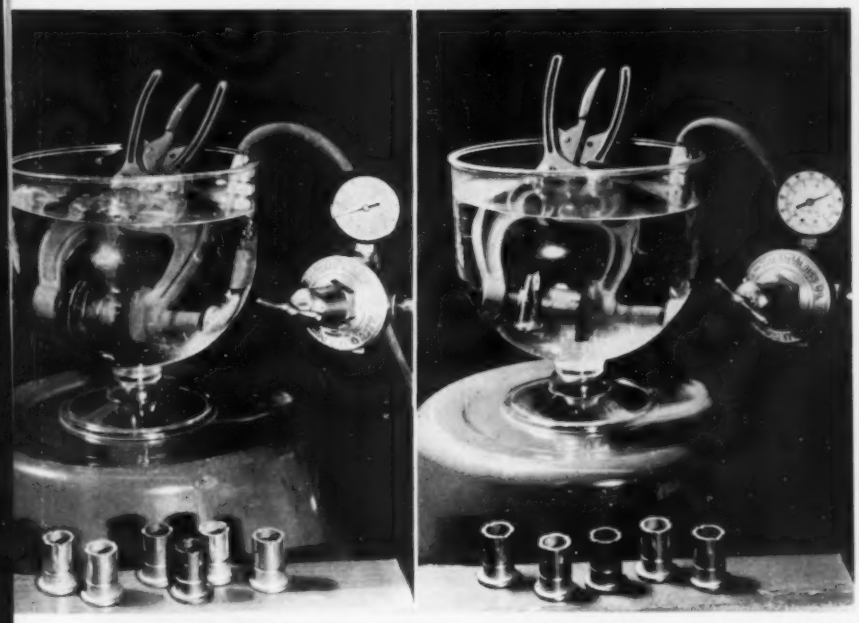

PRESSURE TESTS show how completely a properly applied epoxy resin eliminates porosity in a sintering. Left, unimpregnated pump part; right, impregnated and heat-treated pump part.

Pressure Tight Sinterings

WITH THE right polyester plastic properly applied, sinterings can be made pressure tight and can be successfully electroplated. The trick is the right impregnating compound, the right method of application, and the right processing conditions.

PORES ARE FILLED

One group of impregnants and methods of using them have been developed by the American Metaseal Corp. The process, basically, is to fill the pores of the compact with a polyester plastic material and then heat treat to convert the impregnant into a dense carbonized residue. After this residue is formed the sintering can be treated like any metal part. It heat treats without worry about residual salts being trapped in the pores, can be electroplated readily since the entire surface is an electrical conductor, and, most importantly, is pressure tight.

Evidence of the pressure tightness is shown by the pump impeller illustrated. As originally pressed and sintered, this compact leaked under 10 psi air pressure. After impregnation, it is completely tight at at least 74 psi air pressure.

If the sintered part is to be heat treated to increase strength and hardness, it must be impregnated *before* heat treatment. Normal hardening procedures call for an oil quench. An unimpregnated part will retain small amounts of oil even though thoroughly degreased. These traces of residual oil will make proper impregnation impossible.

MACHINEABILITY

Another advantage of this type of impregnation is improved machineability. Sinterings are, frequently, difficult to machine. The individual powder particles tend to pull out. When properly impregnated and heated to convert the polyester to a carbonaceous material, the machining characteristics are greatly improved. The result is a considerable saving in machining time and an improved machined surface.

Monarch Exploratory Engineering is doing things with castings that have never been done before. New finishes like porcelain enamel on aluminum castings stimulate design thinking...open new horizons for creating new products ...for turning present products into sales leaders. New approaches in design analysis reduce secondary operations...speed production and reduce end costs. Like the P. Y. Hahn's CO_2 powered "Peacemaker .45"...secondary machining is limited to one ream and tapping four holes.

For your new products or current redesign projects let Monarch help you "line your sights" on sure-fire ideas. Call or write for consultations. No obligation.

MANUFACTURING ACHIEVEMENTS in MOLTEN ALUMINUM

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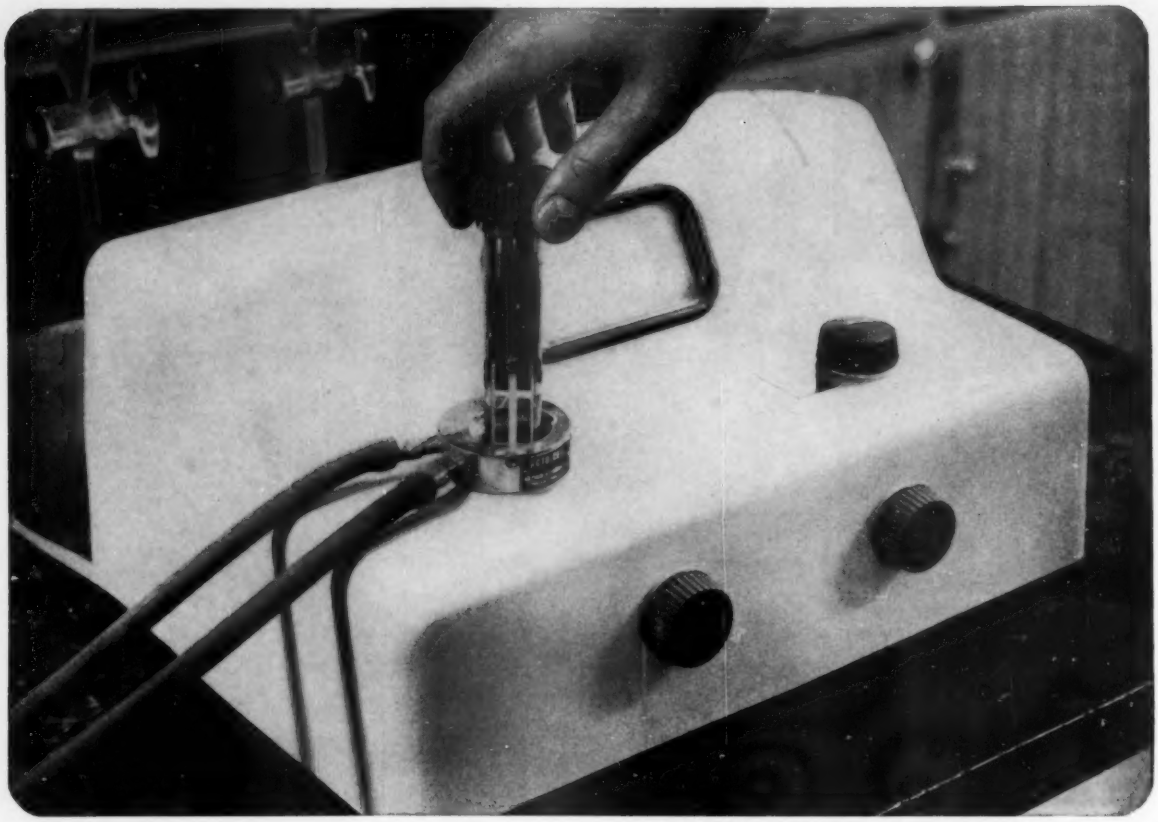
Experience—*the added alloy in* ***Allegheny Ludlum*** *tool steels*



COLORIMETER (inherently extremely accurate) determines percentages of molybdenum, tungsten, cobalt and manganese in A-L tool steel to insure consistent, high quality.

Colorimeter measures exact chemical composition of Allegheny Ludlum tool steel melts

Accurate adjustment of alloys guarantees uniform heat treatment, predictable dimensional changes, reduced grinding, standardized machining operations.

Close control of molybdenum, tungsten, cobalt and manganese is at the heart of a good tool steel melt. In addition to the usual testing methods, Allegheny Ludlum's chemical laboratory checks these metals with Colorimetry because of its inherent, extreme accuracy.

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WSW-7262

Colorimetry is but one step toward careful control over composition. Allegheny Ludlum also sets exacting purchasing specifications on raw materials and scrap. Quality Control checks all incoming orders to see that they conform with these specifications. Another guard toward your getting your exact specifications: each ingot bears a metal tab showing heat number.

Allegheny Ludlum stocks a complete line of tool steel sizes and grades. Call your nearest A-L representative; you'll get quick service and counsel on such problems as heat treating, machining, grade selection, etc. Or write for A-L's publication list which gives full data on the more than 125 technical publications offered. They'll make your job easier.

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PMM OPPORTUNITIES
jobs & equipment

Opportunities rates: $20 for the first column-inch; $15 for each additional column-inch payable in advance. To answer box number advertisements, address responses to the box at Precision Metal Molding. 812 Huron Rd., Cleveland 15, Ohio. Closing date: 1st day of month preceding publication.

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Latrobe, Pennsylvania

Established 1918

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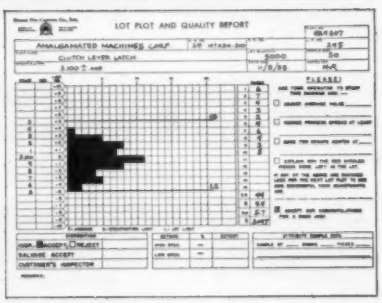

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DATA OFFERED IN THIS MONTH'S ADS

the Reader Service Cards facing the next page will get you these free reference materials. Circle the numbers and mail.

2. Tool Steels — Publication list from Allegheny Ludlum Steel Corp., gives data on more than 125 technical publications offered by the company.

7. Investment Casting — "Practical Guide to Investment Casting", is a 44-page design handbook from Arwood Precision Casting Corp.

9. Sinterings — Engineering Bulletin 3020 from American Sinteell Corp. gives technical data on ferrous and non-ferrous powdered metal products and their design.

11. Sintering — The "Engineering Handbook of Powder Metallurgy", and Catalog No. 58, which lists 2,227 sizes of completely finished cast bronze and sintered oil-filled bearings, are available from Bunting Brass & Bronze Co.

13. Investment Casting — with the Minicast process that can hold dimensional tolerances as close as plus/minus 0.001", is described in a technical bulletin from Casting Engineers, Inc.

14. 3 Technical Booklets — on Refrax silicon-nitride-bonded silicon carbide refractories are available from The Carborundum Co.

19. Fire-Resistant Fluids — Technical bulletin on Cellulubes that are available in six ranges of viscosity. Celanese Corp.

20. Die Castings — Brochure from Di Salle Plating And Die Casting Co., presents a picture story on their facilities for making your specialized die casting.

22. Hydraulic Compacting Presses — Technical data on a complete line of presses that are available in capacities from 2 to 75 tons. Denison Engineering Div., American Brake Shoe Co.

23. Standardized Die Components — which reduce design time and cut die construction costs, are described in a 170-page catalog. The Detroit Mold Engineering Co.

26. Investment Casting Cores — Du-Ceramic, a new material for investment casting cores, is described in technical literature from Du-Co Ceramic Co.

27. Investment Castings — Technical information on investment castings as the possible answer to your design problem, is available from Engineered Precision Casting Co.

29. Eliminate Porosity — Technical bulletin tells how Foseco Degasers eliminate pinhole porosity and oxide inclusions in aluminum castings. Foundry Services, Inc.

30. Eliminate Shrinkage — Technical bulletin tells how Foseco Dycastal, a boiling flux, eliminates shrinkage and cracking in aluminum permanent mold castings. Foundry Services, Inc.

36. Zinc Die Casting Facts — Henning Bros. & Smith, Inc. has issued an engineering data book on "Die Casting With Zinc Base Alloys".

37. Holding Furnace — Bulletin 150, from Hevi-Duty Electric Co., describes the company's new quiet, safe, resistance holding furnace for aluminum.

38. Investment Casting — An illustrated brochure from Hitchiner Mfg. Co., presents technical information on how you can utilize the freedom and savings offered with investment casting.

42. Induction Melting — Technical Bulletin No. 70 from Inductotherm Corp., lists the advantages of Inductomelting equipment.

48. Induction Heating Units — from Lepel High Frequency Laboratories, Inc., for brazing, melting, annealing, etc., are presented in an engineering catalog.

53. Die Casting Components — Accu-Cast by the Shaw Process, are described in a technical bulletin from Manco Products, Inc.

57. Investment Casting — Technical data on the company's Mono-Shell process and castable alloys. Misco Precision Casting Co.

60. Zinc Die Castings — The latest edition of "End Uses of Zinc Die Castings", is available from The New Jersey Zinc Co.

61. Cutting Costs — with brass powder metallurgy. Engineering data booklet evaluates this production method in terms of particular needs. The New Jersey Zinc Co.

64. Cleans, Lubricates — That's what the Air-Lube System, manufactured by Pierce-Waller, Inc. does. Technical data sheets are available.

continued next page

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65. Sinterings—Technical literature on Johnson Ladaloyl Powdered Metallurgy for bronze or iron bearings, bushings, and parts. Johnson Bronze.

66. Investment Materials—that are said to produce better castings with finer detail and smoother finish are described in technical literature. Pre-Vest, Inc.

67. Stearates—Engineering data on Lithium Stearate as a lubricant. M. W. Parsons-Plymouth, Inc.

68. Sintering Savings — A technical report, "How To Cut Costs With The Remet Powdered Metal Process", is available from Reese Metal Products Corp.

70. Master-Molds—and cavity blocks, where you shoot in the lower position and mold vertically, are described in engineering data from Richards Tool & Mold Co.

71. Investment Molds — and Saunders blue wax are described in technical literature from Alexander Saunders & Company.

72. Ladles & Skimmers—Complete data and prices are available from Spincraft, Inc. on their stainless steel ladles and skimmers.

73. Compacting Presses — Technical data on a complete line of compacting presses. F. J. Stokes Co.

74. Statistical Quality Control—for die castings. Technical literature, from Stroh Die Casting Co., Inc., describes their use of quality control for lower inspection costs.

77. Piston Lubricator—Data folder describes the Dorsey automatic piston and cylinder lubricator for aluminum cold chamber die casting machines. Westbrook Mfg. Co.

78. Wax Shapes — Technical literature describes a complete line of wax shapes for investment casting. Yates Mfg. Co.

79. Plating Brighteners — and other process chemicals for the metal finishing industry are described in technical data from Allied Research Products, Inc.

82. Rubberized Abrasives—8-page catalog on rubberized abrasives for deburring, smoothing and polishing tools, dies, patterns, molds, etc. Cratex Mfg. Co.

83. Drilling, Tapping Heads — Engineering data on 5 models of circle or straight line type multi-hole drilling and tapping heads. Ettco Tool & Machine Co., Inc.

84. Flat Finishers—for grinding, polishing and deburring in one operation are presented in technical literature from Hammond Machinery Builders, Inc.

93. Investment Castings — Technical data file on electronics quality precision investment castings is available from Rode, Inc.

96. Hot Work Steel — VDC hot work steel, air hardening, high vanadium, Type H-13, for die casting dies, is described in engineering data sheets from Latrobe Steel Co.

97. Mold Materials — Technical information on mold wash materials, ceramic molding media, shell molding minerals. Harbison-Walker Refractories Co.

16. Investment Casting Supplies — Technical literature and price lists on investment casting supplies. Casting Supply House.

17. Everything—for the investment caster. Technical bulletins from Centrifugal Casting Supply Co. on investments, vacuum mix, automatic industrial injector, etc.

25. Die Castings — 16-page technical brochure on die castings. Shows Dollin Corporation's facilities and services.

33. Industrial Fasteners — Brochure from Gries Reproducer Corp. is a guide to low cost industrial fasteners made of zinc.

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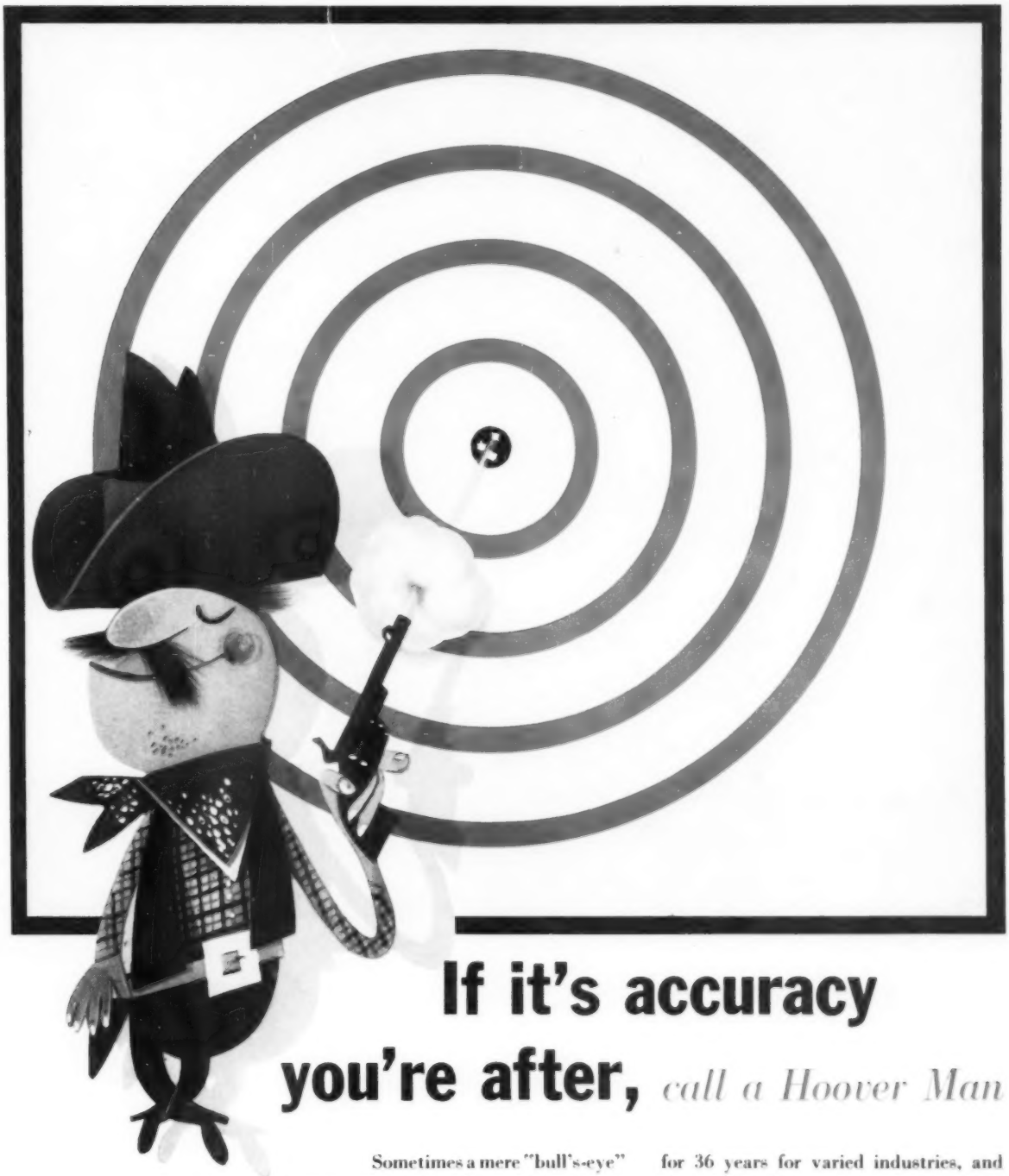

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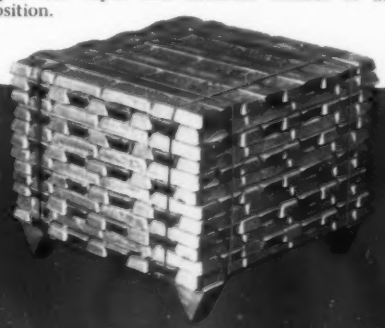
FIRST to develop the lower magnesium contents, .03 to .05%, which eliminated the hot shortness characteristics experienced with .10% magnesium and at the same time was sufficient to prevent the intercrystalline corrosion. Apex promoted in 1931 the first ASTM specification written for zinc base die casting alloys.

FIRST to establish and publish information on the effects of metal and die temperatures on different alloy compositions through actual die casting of thousands of test bars. Apex "Metalgrams" showing these effects were initiated in 1931 and continued through 1945.

FIRST to use large capacity refractory lined furnaces for alloying, replacing the conventional iron metal pots. The larger heats established a uniformity of composition not previously attainable. Iron pickup also was eliminated.

FIRST to employ Quantometers—direct reading spectrographs—for rapid and accurate control of alloy composition.



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